THE

AMERICAN NATURALIST

AN ILLUSTRATED MAGAZINE

OF

NATURAL HISTORY

EDITED BY

ROBERT PAYNE BIGELOW

VOLUME XXXII

BOSTON
GINN & COMPANY
The Athenæum Press
1898

THE

AMERICAN NATURALIST

VOL. XXXII. *January, 1898.* NO. 373.

SYNOPSIS OF RECENT PROGRESS IN THE STUDY OF GRAPTOLITES.

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THE graptolites have been a puzzling group of fossils to palæontologists ever since they were discovered. Though on account of their excessive abundance in certain strata, the beauty and variety of their delicate forms, and the strange mode of their vertical and horizontal distribution they have always received a full share of attention, the knowledge of their morphology has made only little progress, owing to their preservation as completely flattened carbonaceous films. As a result of this incomplete knowledge of their structure, the systematic conscience of palæontologists acquiesced in their being assigned to the Hydrozoa, in spite of the difficulty arising from the formerly commonly accepted presence of the virgula or "solid rod" in the rhabdosome and the supposed floating habit of the graptolites. The fact that they were found to furnish excellent data for the detailed division into zones of the Cambrian, Ordovician, and Silurian strata prevented their neglect, although so refractory to all attempts at close morphologic investigation, and the search for them in the field never relaxed. The grati-

fying result of this persistency is that at last material has been found which is accessible to modern refined preparative methods and to microscopic analysis.

Gümbel ('78) was the first to isolate stipes imbedded in limestone. Later Törnquist ('90, '92) obtained much valuable information by grinding pyritized material. The best results, however, have been obtained by the methods employed lately by Holm ('90, '95) and Wiman ('93, '95). For the details of these preparative methods, the reader is referred to Wiman's interesting account in his paper, "Ueber die Graptoliten" ('95), the review ('96) of his work in the *American Geologist*, and to Wiman's "Structure of the Graptolites" ('96).

Both Holm and Wiman isolated stipes by dissolving the matrix. Various acids have been used for dissolving, according to the nature of the rock. Limestone material was found the simplest to handle, and muriatic acid in different states of solution or milder solvents, such as acetic acid, gave good results. Especially interesting to American readers is the description which Wiman gives of his treatment of highly aluminous clay slates, as these are almost the only graptolite-bearing rocks found here. Wiman subjected them to the successive action of acetic and hydrofluoric acids. J. M. Clarke handled similar material successfully with acids and caustic potash. These methods, however, fail with a matrix that does not contain a sufficient lime-content to lose its consistence by the dissolution of the latter, and this appears to be the case with most of the American graptolite-bearing rocks. Wiman had also occasion to isolate graptolites from chert-masses by successively subjecting the rock to a treatment with concentrated hydrofluoric acid and muriatic acid.

The isolated graptolites have been decolored both by Holm and Wiman in different ways. Wiman used first Schultze's maceration medium, which is a solution of calcium chlorate in nitric acid, but later substituted for it eau de Javelle or potassium hypochlorite, because Schultze's medium is often too harsh. The specimens were then cleared with chloroform or other clearing fluids and mounted in Canada balsam, or, where this method could not be used on account of the thickness of

the periderm, the specimens were prepared for the microtome according to the methods used by zoologists.

By the application of these preparative methods histological and morphological discoveries have been made.

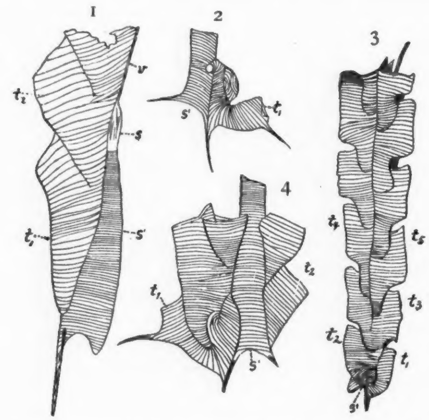
The histology of the graptolites has been especially advanced by the researches of Holm (**'90**), Sollas (**'94**), and Perner (**'94**). The last two investigators demonstrated the presence of three different layers in the periderm of Monograptus; *viz.*, a stronger middle layer between two thinner ones. Wiman (**'95**) verified Perner's observations as to *Monograptus priodon* and discerned the two outer layers in Diplograptus. The middle layer in Diplograptus contains the growth-lines observed repeatedly before. The histology of the Retioloidea has been studied by the above-named geologists and by Tullberg (**'82**) and Törnquist (**'90**, **'93**). Holm found three layers; *viz.*, smooth epidermic and endermic layers, which inclose the latticed network of chitinous threads, from which this group derives its name.

In the Dendroidea Wiman (**'95**) observed the two outer layers.

However interesting the discovery of the differentiation of the periderm of the graptolites is, especially on account of its bearing on the question as to the zoological affinities of this group, it is surpassed in importance by the knowledge which has been obtained as to the morphology and development of the graptolites. In reviewing the progress made in these directions we will separately regard the Graptoloidea, Retioloidea, and Dendroidea.

As an understanding of the conformation of the rhabdosome rests with the knowledge of its growth from the sicula, it will be opportune to review first the fundamental results obtained by Wiman as to the growth of the initial part of the rhabdosomes of Monograptus (**'93**), Diplograptus (**'93**), and some other Graptoloidea. The sicula of these consists of a thin-walled "initial part," which is prolonged into a process, the "virgula," and of the "apertural part," which shows distinct growth-lines and a three-spined symmetrical aperture (Fig. 1, *s*). From the sicula sprouts a new individual, the first theca (Holm considers the apertural part of the sicula already as "first theca"), which

in Monograptus lies alongside the sicula and grows at once in an opposite direction (Fig. 1, *t*). From this theca grows another. The continuation of this process and the arranging of the thecæ in one series along the virgula produces the monoprionidian rhabdosome of Monograptus. Also from the sicula of Diplograptus, as Törnquist ('93) and Wiman found almost simultaneously, there sprouts but one bud, and Diplograptus is, therefore, also monoprionidian. The first theca, however, grows at first towards the aperture of the sicula and then bends in the same



In Figs. 1-8, s = initial part of sicula ; s_1 = apertural part of sicula ; v = virgula ; t = theca.

FIG. 1. — *Monograptus dubius* Suess : sicula end from sicula side (Wiman).
FIG. 2. — *Diplograptus sp.* : sicula end from sicula side (Wiman).
FIG. 3. — The same : a later stage from anti-sicula side (Wiman).
FIG. 4. — *Climacograptus kuckersianus* Holm : sicula side (Wiman).

direction as the thecæ in Monograptus (Figs. 2, 3). The thecæ are arranged in two series, thus producing the diprionidian aspect. The supposition that the diprionidian graptolites consist of two coalescing monoprionidian branches, the double virgula and the double longitudinal septum of the older descriptions, has thus been refuted; the observations of Tullberg, Törnquist, and Wiman prove that not even a single longitudinal septum is always present, and that, if one is present, it does not necessarily extend throughout the entire length of the rhabdosome. Fig. 4, representing a rhabdosome of Climacograptus,

demonstrates that a septum is formed, where the thecæ, instead of sprouting on the opposite side of the adjacent older thecæ (t_1 t_2), spring from the same side as the latter did (t_4 t_5).

Holm ('95) obtained most valuable information on the internal structure and development of some other important genera of the Graptoloidea; *viz.*, of Didymograptus, Tetragraptus, and Phyllograptus. The most interesting result of his researches is the demonstration of the conformity in the first stages of development of the rhabdosomes in these genera and the Diplograptidæ. It is probable, therefore, that the earlier develop-

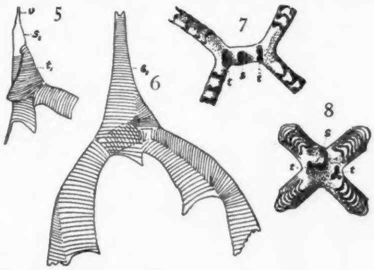


FIG. 5. — *Dichograptid* : anti-sicula side (Wiman).
FIG. 6. — *Didymograptus minutus* Törnquist : anti-sicula side (Holm).
FIG. 7. — *Tetragraptus Bigsbyi* Hall : from the proximal end, with the sicula turned upwards, showing the aperture of the sicula, left and right thecæ, and the thecæ of the four branches (Holm).
FIG. 8. — *Phyllograptus angustifolius* Hall : from the proximal end, with the sicula side turned upwards, showing in the middle the aperture and the oblique position of the sicula, on each side of this the apertures of the left and right thecæ (Holm).

ment of all Graptoloidea was the same, and that it consisted in the formation of only one bud on one side of the sicula.

Fig. 5 (from Wiman, '95) shows the initial part of a Dichograptid, and Fig. 6 (from Holm) of *Didymograptus minutus*. Both figures serve to illustrate the diverging growth of the first two thecæ, which produces the characteristic bifurcation of these forms. The repetition of this process (Fig. 7) in Tetragraptus leads to the formation of four branches. The same takes place in the development of Phyllograptus (Fig. 8), "only that the four branches are disposed near each other and form a single, cruciform, four-winged, longitudinal septum."

The conformity of the rhabdosomes of all Graptoloidea has been made probable by these investigations (the Leptograp-

tidæ and Dicranograptidæ have not yet been isolated). The morphology of the entire colonial stock, however, is, owing to the frequent occurrence of only detached rhabdosomes, still little known. Hall ('65) first described stellate groups of Dichograptidæ from Canada; Hermann ('85) such from Scandinavian rocks; Moberg ('93) published a description of a Monograptus with disk; and Gurley ('96) figured a Climacograptus with a disk-like expansion of the virgula. Ruedemann ('95, '97) discovered colonies of two species of Diplograptus in Utica shale which have been deposited under such conditions of quietude as to retain not only all the chitinous appendages of the mature colonies, but also the successive growth-stages of the compound colonies.

It appears from the material that the rhabdosomes of Diplograptus formed umbrella-shaped colonies, consisting of rhabdosomes of various length, which radiate from a central organ,

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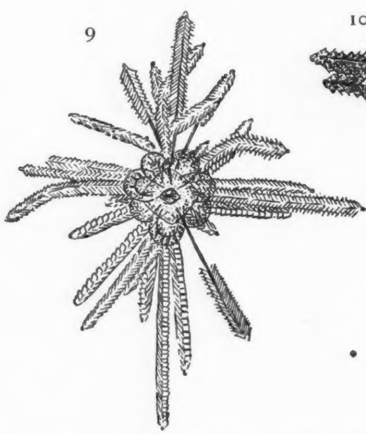

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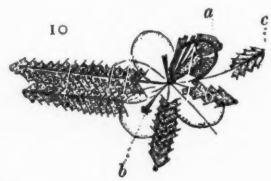
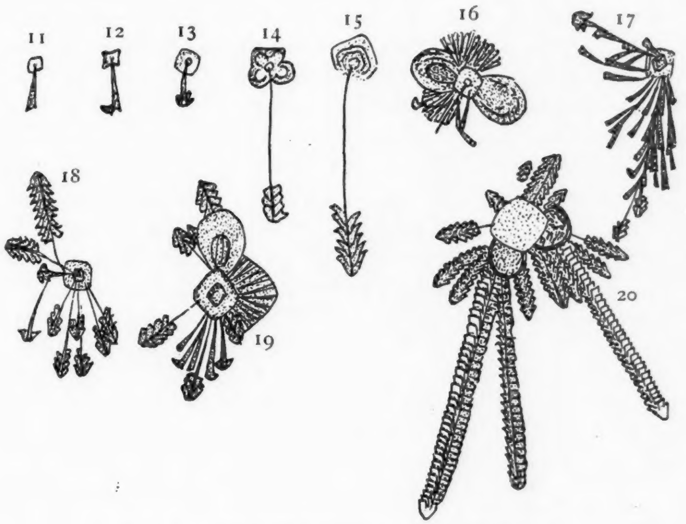


FIG. 9.—*Diplograptus foliaceus* Murch (*D. pristis* Hall): complete colony (Ruedemann).
FIG. 10.—The same: *a*, Gonangium filled with siculæ; *b*, sicula developing into a stipe (Ruedemann).

the central disk (Fig. 9). The latter, in its turn, is connected with a larger organ, the basal cyst, that probably served to secure the stability of the colony in the ooze of its habitat. The central disk is surrounded by a cycle of vesicles which

contain numerous siculæ attached by their apical ends (Fig. 10). The writer compared these vesicles with the gonangia of the sertularians, considering the siculæ as the original chitinous



FIGS. 11–20. — The same: development of a colony (Ruedemann)

coverings of the embryos. (Holm sees in the initial part of the siculæ the covering of the zooid germ.) The development of the colony is as follows:

1. The sicula is provided with a basal appendage to which it is attached by means of a little round node (Fig. 11).

2. The node becomes a central disk and funicle. The sicula produces at first one theca, then a second, a third, etc., as demonstrated also by Törnquist and Wiman (Figs. 12, 13).

3. The budding of the thecæ along the lengthening hydrocaulus produces the primary rhabdosomes (Figs. 14, 15).

4. While the latter is formed, gonangia, usually as four small capsules, arise from the central disk. At last the latter mature and open. Many, or perhaps all, of the siculæ remain connected to the parent colony (Figs. 16, 17).

5. These siculæ grow out to rhabdosomes (Fig. 18).

6. After this first generation of rhabdosomes has reached a certain age a second generation of gonangia begins to grow (Fig. 19).

7. The siculæ formed in these develop into a new verticil of rhabdosomes.

The result of this mode of development is a colony which consists of different generations of rhabdosomes, recognizable by the different lengths of the latter (Fig. 20). An especially remarkable feature of the colonies is the position of the sicula at the distal end of the rhabdosome in regard to the central disk. The explanation of this peculiar position of the sicula is found in the observation that the first theca turns away from the aperture of the sicula and grows towards the apical part of the latter, or towards the central disk, thus forcing the whole rhabdosome to grow backward, so to say, towards the center of the colony. Wiman's figure of the initial part of the rhabdosome of Climacograptus and Gurley's figure of a colony indicate a mode of growth similar to the one described, only that in Climacograptus the colony apparently consisted of only one (the primary?) rhabdosome, as perhaps all siculæ became detached and developed colonies of their own. Also in Monograptus the same mode of growth prevailed. In Phyllograptus the rhabdosome grows also in an opposite direction to the sicula, but no virgula has been found by Holm, and the mode of fixation of the rhabdosome is still doubtful.

In the other genera of the Graptoloidea, however, it has been found that the first theca grows more or less in the direction of the sicula. As a result, the sicula remains near the central disk, at the proximal end of the rhabdosome, and the latter grows distally. In the Dichograptidæ the whole colony is formed by dichotomous branching from one sicula, which remains at the center of the colony.

With the two different directions of growth of the rhabdosomes from the siculæ the presence of a virgula as rod in the rhabdosome is closely connected; for, by the observations of Tullberg, Törnquist, and Holm, the fact has been established that only the Graptoloidea with inward-growing rhabdosomes (Diplograptidæ, Monograptus) have virgulæ, while the others

have none. The explanation of this is found in the observation that the initial part of the sicula of probably all Graptoloidea is prolonged into a process (the virgula of Wiman, the hydrocaulus of Ruedemann, the nema of Lapworth), and that this process in the inward-growing rhabdosomes becomes incorporated as virgula, while in the outward-growing rhabdosomes it remains outside (the nemacaulus of Lapworth). The virgula was originally hollow. This is indicated by Wiman's observations in Monograptus and by the growth of gonangia from the central disk in Diplograptus, which gives the hydrocaulus the character of a stolon.

The demonstration that the virgula or "solid axis" of the older authors is present only in a very restricted number of Graptoloidea is of great interest, as the presence of this organ has been considered as one of the principal characters of the graptolites and has even procured them the name "Rhabdophora." The virgula, as identical with the hydrocaulus or nema of the sicula, is, in reality, present in probably all graptolites, for long filiform processes of the sicula have been observed in numerous genera (*e.g.*, Mæandrograptus, Didymograptus, Tetragraptus). Lapworth concludes from the presence of this process that all rhabdosomes were either fastened to a central disk, as in the Dichograptidæ and Diplograptidæ, or directly by the nema to foreign bodies.

We cannot leave the Graptoloidea without mentioning the important investigations of Tullberg (**'82**), Jækel (**'90**), Perner (**'94**), and Gürich (**'93**, **'96**) on the shape and position of the thecæ, and their apertures in Monograptus, which led to the division of the genus into the two subgenera Pomatograptus Jækel (*Monograpti reversi* Gürich) and Pristiograptus Jækel (*Monograpti erecti*), the interesting study of the phylogeny of the Dichograptidæ by Nicholson and Marr (**'95**), based on the shape of the thecæ, and the work of Miss G. L. Elles (**'97**) on the relations of the subgenera Petalograptus and Cephalograptus.

The knowledge of the structure and development of the rhabdosomes of the Retioloidea is still so uncertain that it can be passed here with the remark that a different number of

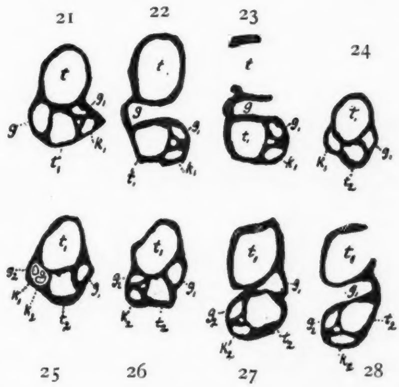
so-called virgulæ and an "initial canal" of the rhabdosome have been observed.

The most interesting discoveries have apparently been made in regard to the third group of graptolites, the Dendroidea. These finely branching, plant-like graptolites, on account of the absence of a virgula and the occasional presence of a distinct organ of fixation, which indicated a sessile mode of life, in opposition to the generally supposed floating habit of the Graptoloidea and Dendroidea, have been mostly separated from the other graptolites, and are often unhesitatingly united with the campanularians (*cf.* Zittel, '79). Their occurrence only as flattened films prevented, until recently, all attempts at closer investigations. The first indication of a more complicate structure was given by Holm ('90) in his description of *Dictyonema cervicorne.* He found that the branches of the rhabdosome in this species consist of vertical rows of thecæ, which end in hayfork-like spines. Situated alternately on two sides of these spines are peculiar cup-shaped bodies ("by-thecæ"), which he compares to birds' nests and supposes to have been gonangia. While Holm first isolated these delicate fossils from the limestone matrix, Wiman ('95, '96) went further, applied the microtome to them, and obtained a complete series of thin sections of Dictyonema, Dendrograptus (?), and Ptilograptus. The important result of his microscopic analysis is the discovery that the morphological structure of the Dendroidea is much more complex than was suspected, and that there are not less than three different forms of thecæ, *viz.*, thecæ proper, or nourishing individuals, alternating canals (Holm's by-thecæ), which Wiman also considers as gonangia, and gemmating individuals. The following illustrations (Figs. 21–28), selected from a series of one hundred and twenty-five sections through a branch of *Dictyonema rarum* Wiman, show this diversity of the thecæ quite plainly. The nourishing individuals are denoted by *t*, the gonangia by *g*, and the budding individuals by *k*. Fig. 22 shows the opening of the gonangium on the right side; Fig. 23, the ceasing of the theca; Fig. 24, the growth of a new theca. In section 25 the budding individual has produced three new individuals, the further growth of

which is shown in section 26, while in section 28 the opening of the next gonangium can be seen.

The hayfork-like outgrowths of the thecæ observed by Holm and Wiman are supposed by the latter to have aided in the process of propagation. In the writer's opinion, they also remind one of the nematocalyces of certain Plumularidæ, which are similar processes provided with a nematophore or altered individual for the purpose of seizing food. They would then constitute a fourth kind of individual.

While it becomes apparent from these discoveries that the three groups of graptolites are more different than had been



FIGS. 21–28. — *Dictyonema rarum* Wiman: series of transverse sections (Wiman).

supposed, it yet seems allowable to retain them in one class. The systematic position of this class seems, by the observed complex structure of the periderm and the high organization of the rhabdosome in general, to have become more uncertain than ever before. As we saw before, the grapolites have, for a long time, quite generally been united with the campanularians. Lately, objections against this union have been raised, especially by Jækel and Neumayr ('89). Wiman holds the same view as Neumayr, namely, that the graptolites cannot be placed in any of the groups of living animals, while Ruedemann sees in the gonangia of Diplograptus a new indication of relationship with the Sertularidæ. Whatever the relations of the grapto-

lites may be, it certainly is necessary for the understanding of the life history of the individuals of the colonies to compare the graptolites with some class of living animals, and there is undoubtedly no other class available but the order of Campanulariæ. It also should not be forgotten that the virgula, which always has been considered as constituting one of the principal differences between graptolites and campanularians, has been proved to be comparable to the hydrocaulus of the first theca of the Campanulariæ.

Another difference between graptolites and campanularians has been supposed to consist in the floating habit of the former. This leads us to the interesting question as to the mode of life of the graptolites, which lately has been discussed by an author (Lapworth, '97) whose lifelong study of these fossils, both in the laboratory and in the field, gives his views the greatest moment.

The peculiar mode of occurrence of the graptolites, *viz.*, in numberless multitudes of broken rhabdosomes in highly bituminous shales, which are otherwise poor in fossils, their astonishingly wide horizontal distribution and limited vertical range, has often been an object of speculation. But it is now to be hoped that, by the light shed lately on the structure and development of the colonies, by the exhaustive study of their distribution, and especially also by the researches which recently have been carried on so extensively in regard to the conditions and distribution of life in the ocean, the clue to the understanding of their mode of occurrence will be found. The works of Walther ('93) and Ortmann ('96) have done much to make the results of these bionomic researches known among geologists, and Walther's investigation has given the direct instigation to Lapworth's valuable discussion.

The common consensus of two generations of geologists, says Gurley, has been that the true graptolites (Graptoloidea, Retioloidea) were "floating." Jækel and Wiman, on the other hand, concluded from the heavy chitinous covering of the thecæ and the presence of the virgula as a supporting rod that the rhabdosomes were not suspended, but that the colonies were lightly moored to the ground. Ruedemann ('97) was forced to

believe in the sessile mode of life of at least one species of Diplograptus by the finding of a slab (*cf. op. cit.*, Pl. V) which showed a great number of well-preserved colonies spread out regularly in about equal distances from each other and arranged in a well-defined area. Gürich (**'96**) and Lapworth (**'97**) have advanced ideas lately as to the mode of life of the graptolites which correspond to each other, and which apparently explain many of the peculiar features in the distribution of these fossils.

Lapworth found in Great Britain that graptolites may occur in all sediments, but that they are found only in great numbers in rocks containing a considerable amount of carbonaceous matter, and that the frequence of the graptolites is directly proportional to the amount of bitumen present and to the fineness of grain in the matrix. As the least motion in the water would carry away the light carbonaceous matter, Lapworth concludes further that the relative frequency of graptolites in a sediment depends also on the quietude of the water in which the rock was formed. This view is especially interesting to the writer in reference to his observation of a parallel arrangement of the rhabdosomes of graptolites in the Utica shale of the Mohawk Valley (**'97**). This arrangement indicates the passing, during the Utica epoch, of a constant current in a northeast to southwest direction along the southern coast of the Adirondack crystalline area. As the alternation of graptolite-bearing shale and coral-line limestone in the lower part of the Utica shale proves, the current must have been strong enough to bring in the fine mud forming the shale, but cannot have been strong enough in the greater depths, where the deposition took place, to drag the well-preserved, delicate rhabdosomes for a long distance. The occurrence of numerous perfect colonies in two localities is proof of the occasional presence of almost perfect quietude. The latter, however, was the rare exception, the rule having been a slight motion, the traces of which can be found throughout the whole system of shales. The fine sinking mud undoubtedly assisted greatly in keeping the carbonaceous matter at the bottom.

Lapworth further opposes the opinion, so often advanced, that the graptolites furnished the carbonaceous matter in the

matrix on the grounds that they are rarely found in a partly decomposed state. From the appearance of the colonies and their fragments, it is concluded that they sank slowly through quiet water to the bottom. As the carbonaceous matter in the rocks is a steady companion of the graptolites, it is supposed to have sunk together with the latter. The source of this carbonaceous matter is found by Lapworth in seaweeds, which, like the living sargassum, were pseudo-planktonic; that is, were originally sessile, but, being torn off, continued to live and were carried by the currents into all seas. Just as the richest fauna of campanularians is still to-day found on the floating seaweeds of the Gulf Stream, so the graptolites are supposed to have flourished on the floating masses of palæozoic algæ. To strengthen this theory, Lapworth calls attention to the fact that it has been found that the rhabdosomes are either fastened to a central disk or have at least a nema. Both central disk and nema indicate that the graptolites were sessile. The Dendroidea alone, which are never so common as the other graptolites, fastened themselves to rocks and stones, and belonged to the "benthos" (lived at the bottom). Originally, however, all graptolites were benthonic, and become only later pseudo-planktonic. This change in the habitat necessitated a change also in the direction of the thecæ, which is indicated in the course taken by the first theca of Diplograptus (Fig. 2), and by the direction of the thecæ of Monograptus and of the branches of Didymograptus, Tetragraptus, and Phyllograptus.

It cannot be denied that the peculiarities of the distribution of the graptolites and their structure are well explained by Gürich's and Lapworth's theories. It is highly probable that many graptolites were indeed pseudo-planktonic, while some may even have gone further and have become free-floating or planktonic, and others are known to have been sessile at the bottom.

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CONTRIBUTIONS ON THE LIFE HISTORIES OF CERTAIN SNAKES.

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In reading over the magnificently compiled monograph of the poisonous snakes of North America by Mr. Leonhard Stejneger, and also an article on the breeding habits of snakes by Dr. O. P. Hay, in the *Proceedings of the U. S. National Museum* (Vol. 15, 1892), I find many points of character as well as of the reproduction which appear, according to both writers, very obscure.

My observations, extending over a period of nearly twenty years, were made principally on ophidians, occurring in central Europe, Central America, and our southern states, chiefly Louisiana, and were conducted both in nature as well as confinement, the latter especially with a view to note the extent of the exceedingly limited mental capacity and the development of their sense organs. I have noted the entire period of gestation of at least three of our venomous snakes from the time of sexual union to the end of the term, and I dare say with comparative certainty that the same length of gestation occurs as well in *Natrix rigida* and *Natrix grahamii.*

The term of gestation may vary to a limited number of days, but all my notes point to five months and a few days.

While searching for reptiles in the vicinity of New Orleans on the 10th of March, 1893, I happened to come across a pair of *Agkistrodon piscivorus* in coitu, which must have, evidently, been nearly or quite completed, for the male freed itself so quickly that I failed to secure it, but the female, an unusually large one, became my captive.

She proved to be a very aggressive and obstinate individual for quite a long time, and refused food persistently for fully two months. The cage in which I kept her was prepared with some imitation of natural surroundings, and after the expira-

tion of about two months the snake commenced to feed on mice, and before another month passed by she swallowed pieces of raw beef and fish with avidity. I continued to feed her at the point of a little stick fairly regularly every two or three days. About four months from the day I caught her I noticed an increase in her size, but, of course, I could hardly credit my surmise at first. On August 17, however, she produced nine young ones. She killed one by lying on it, but the other eight were lively, in markings the same as the mother, but more distinct, and the ground colors much more reddish and brighter. To test their poisonous qualities I permitted one of them to bite me on the following day, but outside of the peculiar penetrating sensation attendant upon all venomous snake bites, and not unlike a bee sting, I did not feel other results. The young snakes measured exactly six and three-eighths inches in length, and in their thickest diameter four-fifths of an inch. The mother and five of her babies are now in the collection of Tulane University, all having died the following winter.

The winter of 1893–94 proved quite severe up to the end of February, 1894, and reptiles did not appear until then; but when I came to Avery's Island, on the last day of March, Mr. E. McIlhenny had collected for me a number of snakes, among them a full-grown ground-rattler (*Sistrurus miliarius*).

As soon as I reached New Orleans again, a few days later, I prepared a suitable cage for that snake. The first mouse I offered was killed and swallowed with the greatest promptitude. The deportment of this little rattler was not at all vicious, and after a short while would pay but little attention to what was going on in and about the cage; she even showed no signs of irritability if I accidently touched her with my hand while removing her water pan or cleaning out the cage. But I never succeeded in getting her to eat anything except mice. Toward the middle of July I noticed a gradual increase in her size, especially in the posterior portions, and on August 12 she gave birth to six little ones. They were born during the night, and I found each one of them curled up in the manner of the old one in different places in the cage. The newcomers were

the exact counterpart of their mother in color and markings, the ground color, however, much lighter, and the head being much more obtuse. Their length was five and one-half inches by a trifle less than one-fourth of an inch.

According to the condition of the weather and temperature, it is hardly possible that the snakes left their winter quarters before the beginning of March; mating must have taken place soon after, and, supposing it to have occurred about the middle of March, it will then determine the term of gestation to five months, or possibly a trifle over.

While on Avery's Island I captured, on April 1, two large water-moccasins. I kept the pair isolated from other snakes, but exactly thirteen days (August 25) after the birth of the ground-rattlers I came also in possession of eight young water-moccasins.

The same conditions as to temperature and the appearance of the snakes after hibernation prevailed in this case, and we find the term again to be five months and possibly a few days more.

In regard to the quotation of the notes on the pairing, etc., of *Agkistrodon piscivorus*, as observed by Effeldt in the Berlin Zoological Garden,[1] the period of gestation is considerably over five months. The dates, however, appear to have been noted with accuracy, and the excess of days in the period, if compared with my own notes, may be due to the climatic conditions under which the occurrence took place; but the statement of the size of the young at birth, as well as the color and markings, I believe to be unquestionably wrong. Our largest Crotalidæ never bring forth young of the length of ten and two-fifth inches, much less a water-moccasin.

On April 12, 1895, a negro came to me with an ordinary bird trap-cage. In it he had two magnificent copperheads, which he said he had caught on the previous evening in a cane-brake in the act of copulation. I purchased them and devoted considerable time to their care. Both of them accepted food very readily, and after awhile became gentler and more tractable, a trait which seems to me very much pronounced in copperheads,

[1] *Report of U. S. National Museum*, 1893, pp. 409, 410.

as I have found repeatedly illustrated in a number of other individuals of that species. I did not notice anything unusual until late in the evening of September 16, when the female (the larger one of the two snakes) brought forth seven young. These again were marked and colored like the parents, only more brilliantly. I have certainly no reason to doubt the negro's statement, especially as a later dissection proved the other snake to have been a male. The term of gestation is in this case again five months and four days. On May 3 of the same year some students brought me three specimens of *Natrix grahamii,* which they had caught in our university grounds. Two of the snakes were females. In September five young were born alive, while a sixth one remained dead in the membranous eggshell, although it had been expelled from the parent's body. I noticed that the food yolk of these little creatures was much larger and remained attached to them longer than in the young of the poisonous snakes.

In regard to *Eutænia proxima* and *E. sirtalis,* I am confident that, while, of course, the species are ovoviviparous as well, the number of young at one time is rarely more than eight or nine. Twice I have had young ones of that species born in confinement, at one time only five, at another, eight. They were five and three-fourths inches in length, and fully three-sixteenths of an inch in thickness. As to the term of gestation I am not certain, but pairing occurs in March and April, for I have had repeated opportunities to observe it in our swamps and palmetto thickets.

The structure of the membranous eggshell of all ovoviviparous snakes seems to be alike; it is very thin and perfectly transparent, and causes no difficulty to the young snakes to rupture it. The egg tooth, however, I have been able to find only in the young of *Natrix grahamii.* The motion of rupturing the inclosing membrane I saw very nicely demonstrated by the young of *Agkistrodon piscivorus.* The vertex lies close to the side of the wet and slimy shell; the simple motion of drawing the tip end of the nose upward and backward suffices to make an opening large enough for the little creature to crawl forth. All snakes shed skin from three to ten days after

birth. The food yolk remains attached for some time after birth, and *is not entirely absorbed before.*

There is certainly a grave mistake in Dr. H. C. Bumpus' account of *Eutænia sirtalis* (quoted in the *Proceedings of the U. S. National Museum*, Vol. 15, p. 388), for the genus Eutænia, as stated before, is ovoviviparous, and the young are marked just like the old ones, only much more brilliantly. Dr. Bumpus must have found the eggs of *Bascanion constrictor.*

According to the just-stated observations, the term of gestation seems to me definitely defined. At the same time we must also give credit to other statements, and the question arises, Do snakes copulate twice a year? Observations made by me in Europe on *Pelias berus*, *Vipera redii*, *Tropidonotus natrix*, and *Coronella lævis* seem to contradict such an assumption. In all cases, with the exception of *Vipera redii*, I have seen copulation in captivity, and I found the desire for reproduction to manifest itself in April and May, the young of Pelias and Coronella to be born in August and September, but the eggs of Tropidonotus to be laid in June and July. I placed freshly laid eggs of *Tropidonotus natrix* and *T. persa* in dunghills, and twenty-three days later I obtained the young ones. It is remarkable to notice the tenacity and intent with which the males persist in following up the females during the time of sexual desire.

How much I was mistaken in rating the toxic qualities of very young venomous snakes is illustrated by the following history of the bite of a young *Sistrurus miliarius.* As stated before in this article, I tried the effects of the bite of a young water-moccasin and experienced no results worth while mentioning.

During the noonday hour of Aug. 20, 1894, exactly eight days after the birth of the young ground-rattlers, I picked one of them up, teased it a little, and presented the first joint of the little finger of my right hand for a bite. The little snake bit with a vengeance. The momentary sensation resembled the sting of a bee; at the same time a lightning-like pain seemed to shoot up to the shoulder. A few minutes later actual pain extended to the second joint; a slight discoloration

around the wound, which, by the way, was scarcely perceptible, set in, indicating the destruction of the capillary walls and consequent extravasation. Œdema also made its appearance, and in a short while both swelling and pain increased in violence, extending gradually to the wrist and forearm, causing a numb sensation in the elbow joint, which sensation, however, disappeared again as the pains became more severe, and extended further up toward the shoulder. In less than an hour I was hardly able to raise my arm. Up to two hours after the bite the symptoms seemed to be merely local, but after that time they became systemic. General oppression and a slight degree of subjective vertigo commenced to be noticeable, both sensations increasing and remaining until after nightfall, and by eight o'clock dyspnœa became very troublesome. This feeling lasted until half past eleven, when I went to bed. The pain, however, which in the meantime increased in violence and extent, caused me to pass a sleepless night. By daybreak the swelling had extended well down my right side and upwards, even involving the same side of my face. Neither dilatation nor contraction of the pupil was noticeable. The pectoral region was extremely painful, but no such symptoms appeared in the scapular. The little finger was swollen to double its size, and the wound appeared like two black dots. The whole hand, as well as part of the forearm, showed upon pressure an exaggerated degree of resilience and heat. The temperature rose to one hundred and three degrees during the night, but by ten o'clock the following morning had subsided to ninety-nine and three-fifths. From that time on reaction set in, the symptoms gradually subsided, but an uncomfortable feeling throughout the entire system remained up to a period of thirty-six hours. After three days swelling and inflammation had almost all disappeared. Pains upon pressure, however, were noticeable as yet in the entire area which had been involved, and the discoloration in the axilla was very marked. Suppuration did not take place anywhere. No remedy had been applied from beginning to end.

The development of the sense organs in snakes leaves one in doubt at times just how far it extends. Sight is fairly good as

long as the object is moving; but I hardly think there is enough comprehension to distinguish a rat or frog as long as they will keep perfectly still. I have noticed that a snake will follow its victim around and around with its eyes, but, even if it should stop suddenly right in front of the snake and in convenient distance to strike, and keep perfectly motionless, the snake appears to be in doubt of its identity; the slightest muscular twitching in the victim, however, is then of course sufficient to overcome the uncertainty and hesitancy of the snake.

Smell is imperfectly developed, but it is amply supplemented by their exquisite feeling in the ends of the tongue. The sensitiveness of that organ is so fine that an absolute touch does not seem to be necessary, but the impression is conveyed to quite a long distance, sometimes for an inch or two. In regard to hearing, it is rather difficult to obtain accurate knowledge. At times it appears very acute, and at others no attention whatsoever is paid to sounds. If snakes are very alert and some noise is made, without disturbing the cage in the least and without making oneself visible, I found that they would catch up the sound waves very readily, and conveyed the fact by turning their head quickly in the direction of the sound and by their rapid display of the tongue.

The most careful and thorough observations, however, have so far not brought me to the solution of that bugbear of herpetologists, the use of the pit of the Crotalidæ and their next of kin, the moccasins. The assumption of the existence of a sixth sense is certainly easily maintained by the anatomical structure of the pit and the ramifications of the nerve in its linings.

On the life of some of our venomous snakes in captivity a few remarks may not be out of place. It is generally believed that they refuse food persistently and finally die of starvation. I have found, however, that the majority will accept living food without hesitation, as long as their receptacle is in any way arranged like their native haunts. The most interesting of our venomous ophidians I consider the copperhead, which in captivity becomes very tame, learning to take food, such as pieces of meat and fish, from the fingers. I possessed one some time

ago which would drink water out of a small graduated glass while I held it in my fingers. This snake learned to know very well that when I opened its cage door something in the line of food or drink was forthcoming. Several other copperheads that I kept at different times became quickly tame, and I found them easily satisfied with pieces of fish, which they preferred to beef. Water-moccasins became very tame also, but they are much more sluggish, and therefore less interesting. Of the latter I kept one pair nearly seven years in the cage. I suppose I would have them still if some one had not killed them by throwing boiling water on them when I was taken ill.

The greatest enemy of snakes kept in captivity I found to be a flat worm, shaped and colored almost like a leech, which penetrates all tissues. I found them at one time in the pericardium of a rattlesnake. Once these parasites manifest themselves, it is generally the death warrant to all snakes kept in confinement at the time. Another very troublesome and usually fatal affection appears in the shape of brownish-looking pustules; they are malignant, and the only chance in keeping the other snakes is isolation of the affected ones. I have seen a few recover by rupturing the pustules and sprinkling aristol on them.

In conclusion I may add that some weeks ago I received seven specimens of *Crotalus atrox* from San Antonio, Texas. Six of them are full grown; the other one is a small one of about eighteen inches in length, which is feeding lustily on Anolis. The venom of this little snake is evidently of considerable strength, for the death of the lizard ensues almost instantaneously after the bite. Three of the other six are evidently males. Sexual congress took place between one pair on May 14. The males are a little smaller and darker than the females. All are very excitable at present, any noise about the room being sufficient to start them to rattle. There seems to be absolutely no limit to their rattling. So far all of them have refused food. A young rat, which I put into the box, I had to remove again after two days, for the snakes never attempted to kill it.

CLASSIFICATION OF LAKES ACCORDING TO TEMPERATURE.

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In view of the increasing attention that is being given to the study of the temperature of the water in lakes and ponds it seems advisable to establish some system of classification by which we may group these bodies of water according to their temperature, thus giving additional value to the data accumulating on the subject. A suggestion for such a classification is here presented. It may add to a better understanding of the subject if we refer briefly to the temperature changes which take place in a body of water and the practical importance of the physical phenomena which they produce. We cannot do better, perhaps, than to take Lake Cochituate as an example and study it by the aid of the diagram in Fig. 1. The curves in this diagram are based on a seven years' series of weekly observations, but certain irregularities have been omitted for the sake of simplicity. If we trace the line of surface temperatures, we observe that during the winter the water immediately under the ice stands substantially at 32° F., though it may be added that the ice itself often becomes much colder than 32° at its upper surface. As soon as the ice breaks up in the spring the temperature of the water begins to rise. This increase continues, with some fluctuations, until about the first of August. Cooling then begins and continues regularly through the autumn until the lake freezes in December. If this curve of surface temperature were compared with the mean temperature of the atmosphere for the same period, a striking agreement would be noticed, and it would be seen that the water temperature is the higher of the two, — probably because of the direct heat received from the sun. In shallow ponds this effect is very marked, but in large, deep lakes,

where the water circulates to considerable depths, the atmospheric temperature is usually higher than the water temperature.

The temperature at the bottom of Lake Cochituate during the winter, when the surface is frozen, is not far from that of maximum density (39.2° F.). The heaviest water, therefore, is at the bottom and the lightest at the top, the intermediate layers being arranged in the order of their density. Repeated

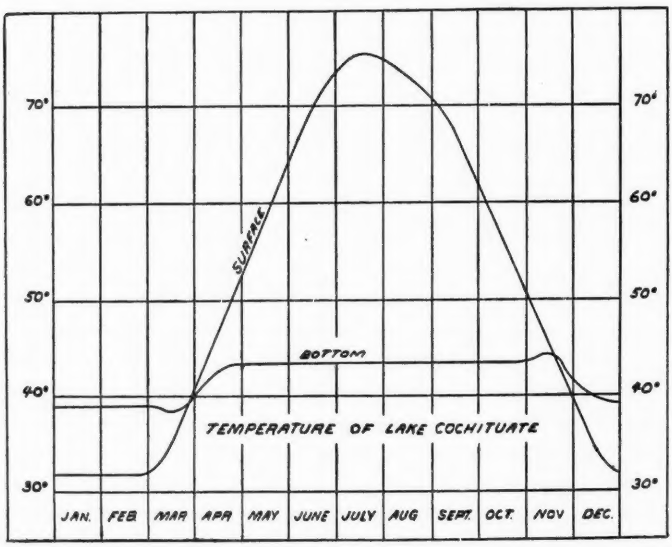

FIG. 1.

observations have shown that the colder water occupies a comparatively thin stratum under the ice, and that the temperature at a depth of ten feet is not much lower than at the bottom. With these conditions the water is in comparatively stable equilibrium. There is no tendency for it to circulate vertically. It is in a condition of "inverse stratification," as Forel calls it, when the colder water is above the warmer. It is the "period of winter stagnation." In the spring when the ice breaks up the cold surface water becomes mixed to a certain extent with the warmer water below it, and the bottom temperature drops

slightly. Soon the surface and bottom layers come to have substantially the same temperature, and vertical currents extend from top to bottom. This is the "period of spring circulation," or the "spring overturning." It lasts several weeks, but varies in duration in different years. As the season advances the surface water becomes warmer than that at the bottom, and finally the difference becomes so great that the wind is no longer able to keep up the circulation. Consequently, the bottom temperature ceases to rise, the water becomes "directly stratified," and the lake enters upon the period of "summer stagnation." During this period, which extends from April to November, the bottom temperature remains constant and the water below a depth of about twenty-five feet remains stagnant. This bottom temperature during the summer varies with different years, depending upon the meteorological conditions at the time when the period begins. In the autumn, as the surface cools, the water becomes stirred up to greater and greater depths, until finally the "great overturning" takes place, and all the water is in circulation. At this time there is a slight increase in the bottom temperature. Then follows the "period of autumnal circulation," during which the surface and bottom layers have substantially the same temperature. In December the lake freezes and "winter stagnation" begins.

Thus during the year there are two periods of circulation and two periods of stagnation. These physical changes have an important effect upon the quality of the water. During the stagnation periods much of the suspended matter in the water settles to the bottom, where there is already a large accumulation of organic matter. This decomposes, robbing the lower layers of water of all the oxygen present. Decomposition then goes on under the influence of the anærobic bacteria, and the water becomes charged with the products of decay. By the end of the stagnation period the lower layers have a very high color and a bad odor. At the overturning the foul water is carried into circulation, and its effect is noticed throughout the entire body of water. Nor is this all. The circulating water brings up from the bottom certain micro-organisms which have been lying dormant, and the products of decay alluded to

become changed into food material suitable for them; consequently, the organisms develop and the quality of the water suffers.

This matter of stagnation with its unpleasant effects is an important one for water-works engineers to study. The growth of organisms is closely connected with the presence of organic matter at the bottom. Observations have shown that if the organic matter is absent the organisms do not grow to any great extent. The best modern practice in the construction of reservoirs for water supply, therefore, indorses the removal of the soil from all areas to be flooded. This, however, is usually a matter of great expense, and, for that reason, some engineers do not consider it advisable to remove the soil from very deep reservoirs. In the opinion of the writer this position is well taken only in the case of reservoirs so situated and so deep that there is practically no circulation of the water at the bottom, and, therefore, no opportunity for any foul matter to be carried upwards.

The requisite depth for the attainment of such a condition is at present unknown. We know that in some very deep lakes the water at the bottom remains constantly at the temperature of maximum density, but we do not know how much this depth must be diminished in order to have circulation take place. Moreover, the depth is not the only factor concerned. The size and shape of the lake, its geographical location, and the nature of the surrounding country all have their effect upon the circulation of the water. As the vertical circulation of water can be studied best by means of its temperature, we see how valuable it would be to have regular and continued temperature observations made at various depths in our deep lakes and ponds. The observations thus far made are far too few to enable us to establish the point desired.

According to the classification here suggested, lakes and ponds are divided into three types, according to their surface temperatures, and into three orders, according to their bottom temperatures. The resulting nine classes are shown in Fig. 2. On these diagrams the boundaries of the shaded areas represent the limits of the temperature fluctuations at different depths.

The horizontal divisions represent temperatures in Fahrenheit degrees increasing towards the right, and the vertical divisions represent depth. The three types of lakes are designated as *polar*, *temperate*, and *tropical*. In lakes of the polar type the surface temperature is never above that of maximum density; in lakes of the tropical type it is never below that point; in lakes of the temperate type it is sometimes below and sometimes above it. This division into types corresponds somewhat closely with geographical location.

The three orders of lakes may be defined as follows: lakes of the first order have bottom temperatures which are prac-

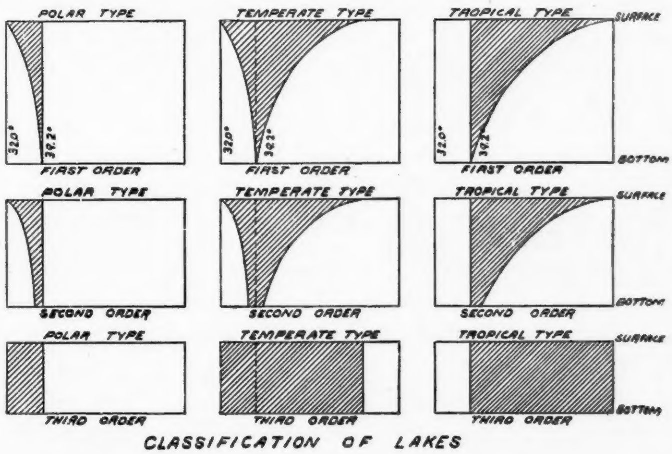

FIG. 2.

tically constant at or very near the point of maximum density; lakes of the second order have bottom temperatures which undergo annual fluctuations, but which are never very far from the point of maximum density; lakes of the third order have bottom temperatures which are seldom very far from the surface temperatures. The division into orders corresponds in a general way to the characters of lakes; *i.e.*, size, contour, depth, surrounding topography, etc.

This classification is essentially the same as that recently proposed by Forel. He divides lakes into three types, polar,

temperate, and tropical, but bases the distinction upon bottom temperatures instead of surface temperatures, as follows:

1. *Tropical Type:* Temperature of deep layers varies from and above maximum density.

2. *Temperate Type:* Temperature of deep layers varies above and below maximum density.

3. *Polar Type:* Temperature of deep layers varies from and below maximum density.

He subdivides each type into two classes, deep and shallow, defining deep lakes as those which have a constant bottom temperature, and shallow lakes as those which have a variable bottom temperature. This subdivision is not a happy one, as observation shows that there are many lakes which would unquestionably be called "deep" which have a variable bottom temperature.

The temperature changes which take place in the nine classes of lakes according to our system of classification are exhibited in another manner in Fig. 3. These diagrams show by curves the surface and bottom temperatures for each season of the year, the times being plotted as abscissæ and the temperatures as ordinates. The shaded areas show the difference between the surface and bottom temperatures, the wider the shaded area, the greater being the difference.

A study of these diagrams brings out some interesting facts concerning the phenomena of circulation and stagnation. In Fig. 2 it will be seen that the circulation periods occur when the curve showing the temperatures at various depths becomes a vertical line; that is, when the water all has the same temperature. The stagnation periods are shown by the line being curved, the top to the right when the warmer layers are above the colder, and to the left when the colder layers are above the warmer. In Fig. 3 the circulation periods are indicated by the surface and bottom temperature curves coinciding, and the stagnation periods by these lines being apart. The distance between the lines indicates, to a certain extent, the difference in density between the top and bottom layers, and we see that the farther apart the lines become the less likelihood there is that the water will be stirred up by the wind.

In lakes of the polar type there is but one opportunity for vertical circulation (except in the third order), namely, in the summer season, when the water approaches the temperature of maximum density. In a lake of the first order, that is, in one where the bottom temperature remains constantly at 39.2°, the circulation period would be very short indeed, if not lacking altogether. In a lake of the second order circulation might and

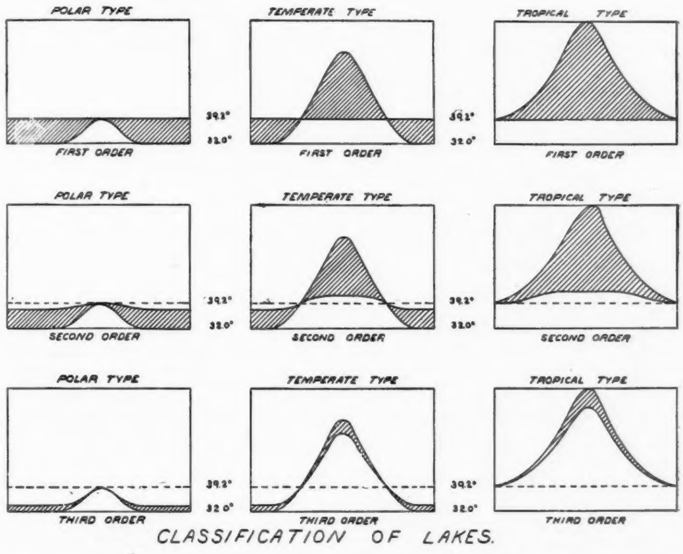

Fig. 3.

probably would continue for a longer period. In a lake of the third order the water would be in circulation nearly all the time except when frozen. The minimum temperature limit indicated for this order, *i.e.*, 32° at all depths, would be possible only in very shallow bodies of water, and would simply indicate that all the water was frozen; the temperature of the ice would probably be below 32° at the surface. It is probable that very few polar lakes exist.

In lakes of the tropical type there is likewise but one period of circulation each year (except in the third order). This would

occur not in summer, but in winter. In the first order this circulation period would be brief or entirely wanting; in the second it would be of longer duration; in the third order the water would be liable to be in circulation the greater part of the year. Tropical lakes are quite numerous, but observations are lacking to place them in their proper order.

Most of the lakes of the United States belong to the temperate type. In this type there are two periods of circulation and two periods of stagnation (except in the third order), as we have seen illustrated in the case of Lake Cochituate. In lakes of the first order the circulation periods would be very short or entirely wanting; in the second order the circulation periods would be of longer duration; in the third order the water would be in circulation throughout the year when the surface was not frozen.

If we recapitulate in tabular form, we have the following:

CIRCULATION PERIODS.

	POLAR TYPE.	TEMPERATE TYPE.	TROPICAL TYPE.
1st Order.	One circulation period possible, in summer, but generally none.	Two circulation periods possible, in spring and fall, but generally none.	One circulation period possible, in winter, but generally none.
2d Order.	One circulation period, in summer.	Two circulation periods, in spring and autumn.	One circulation period, in winter.
3d Order.	Circulation at all seasons, except when surface is frozen.	Circulation at all seasons, except when surface is frozen.	Circulation at all seasons.

Speaking in very general terms, we may say that lakes of the first order have no circulation; lakes of the third order have no stagnation (except in winter); and lakes of the second order have both circulation and stagnation.

In view of the comparatively few series of observations of the temperature of our lakes, the writer refrains from making any classification of the lakes of the United States, but the

results thus far obtained seem to indicate that the first order will include only those lakes more than about two hundred feet in depth, such, for instance, as the Great Lakes, Lake Champlain, etc.; the second order will include those whose depth is less than about two hundred feet, but greater than about thirty feet; and the third order will include those whose depth is less than twenty-five feet. These boundaries are only approximate, and it should be remembered that depth is not the only factor which influences the bottom temperature.

Instead of citing long tables of figures giving the results thus far obtained, which would materially lengthen this paper, the writer prefers to cite a list of references which the reader may consult.

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BOTANICAL ASPECTS OF JAMAICA.

DOUGLAS HOUGHTON CAMPBELL.

On May 27, 1897, in company with Prof. D. T. MacDougal, the writer sailed from Boston for Jamaica to make an inspection of the island, for the purpose of determining its availability for the location of a tropical station for botanical research.

The voyage was neither eventful nor, the first part at least, pleasant, as a cold rain prevailed much of the time, making a stay on deck impossible, except at the expense of a thorough drenching. About the fourth day out it grew warmer, and the bright blue of the water, with great masses of floating gulf weed, announced our approach to the tropics. On the fifth day land was sighted, — Watling's Island, or, as we knew it in our histories, San Salvador. Gazing at the low shore line, with its white lighthouse, we tried to imagine the sensations of Columbus when he first saw this outpost of the American Continent. The next morning we were rounding the barren shores of southeastern Cuba, and coasted the southern shores of that island nearly all day. We had now left the chilly air and dark waters of the North Atlantic and were enjoying genuine tropical weather. The vivid blue waters of the Caribbean Sea and the hot sunshine spoke eloquently enough of low latitudes.

The sun set before we came in sight of Jamaica, and it was past midnight when the light of Port Antonio could be distinguished. Although it was intensely dark, the land breeze, bearing indescribable scents of the land, and the chirping and buzzing of innumerable insects told us we were near *terra firma*.

As soon as we could have our baggage passed through the custom-house we drove at once to the hotel, where the comfortable beds and spacious rooms were very welcome after the confined quarters on shipboard. On awakening the next morning our eyes were greeted with the sight of cocoa palms, breadfruit trees, bananas, and other evidences of the tropics.

The warm, humid atmosphere was not especially conducive to hard work, especially after the chilly air we had left behind us, and for a few days we contented ourselves with becoming acquainted with the immediate surroundings of the beautiful harbor of Port Antonio. This is the principal port of the northern side of the island, and is most beautifully situated within sight of the Blue Mountains, the highest range in Jamaica. The shore formation is largely coral, and the rocks are covered with luxuriant vegetation to the water's edge. The heavy rainfall—about one hundred and fifty inches annually—induces a marvelously rapid growth of all kinds of plants, and everything is fairly buried in the rank growth. Along the coast cocoanut palms abound, and where the shores are muddy mangrove swamps are a conspicuous feature.

Although most of the country about Port Antonio is under cultivation, cocoanut and banana plantations predominating, still the native vegetation quickly takes possession of the neglected lands, and roadsides and hills furnish abundant and interesting material for the botanical collector. Among the most unfamiliar plants to Northern eyes are the climbing aroids, Philodendron and Syngonium, which, with their terrestrial relatives, Alocasia, Dieffenbachia, and other less common forms, contribute much to the tropical aspect of the prevailing vegetation. The sensitive plant is a common weed, and showy Thunbergias and other creepers abound. Of the ferns the most noticeable forms were a very common Anemia, and at slight elevations Gleichenia and a very beautiful Lygodium. Various Alsophilas and other tree ferns were not uncommon, but not nearly so fine as those at higher altitudes. A climbing Davallia, with prickly stems, was also conspicuous.

A railroad now connects Port Antonio with Kingston, which lies upon the southern shore of the island. The trip over this road is a most enjoyable one, as it traverses some of the most picturesque parts of the island and gives an excellent idea of its general topography and vegetation. For about thirty miles the road skirts the seashore, showing in places sandy beaches, but more commonly coral rock coming down to the water, carved into fantastic shapes by the action of the waves.

Along the sandy beaches *Ipomoea pes-caprae* abounds, and with this the curious "shore grape," Coccoloba, and other characteristic forms are common. In many places are depressions just back of the shore, and these form swampy jungles, with the trees laden with a perfect tangle of lianas and other epiphytic growths. Here and there in the more open places are groups of prickly stemmed "groo-groo" palms (Acrocomia), — the first indigenous palms we had seen.

Leaving the shore, the road passes over the mountains and part of the time is in sight of the forest, although for the most part the land along the route of the railroad is under cultivation. As we ascend the tree ferns become common, and a number of beautiful palms are noticed, among them the superb cabbage palm, *Oreodoxa oleracea,* with its slender, straight shaft shooting up sometimes a hundred feet and more. Gigantic bamboos cover the hillsides and grow in great masses along the streams, their exquisite green plumes being among the most beautiful of vegetable growths. This magnificent plant has been introduced probably from India, but is now thoroughly naturalized all over Jamaica.

As the summit is passed and the descent toward the southern side of the island begins, a difference in the character of the vegetation soon becomes apparent, and the very much diminished rainfall on this side of the island is at once indicated by the very different plants met with. This becomes more and more marked as Kingston is approached. Leguminous trees, Prosopis, logwood (Hæmatoxylon), Pithecolobium, characteristic of a drier region, are common, and several Cacti, Opuntias, and species of Cereus give a very distinct stamp to the landscape. The contrast between the semi-arid country about Kingston and the rank luxuriance of the vegetation at Port Antonio is most striking.

At Kingston we were met by Mr. Fawcett, the director of the public gardens of the island, who throughout our stay did everything possible to aid us in our work. Had it not been for his kindness it would have been quite impossible for us to have made our trip as successful as it was.

While in Kingston we were entertained at Mr. Fawcett's charming home in the Hope Gardens, about six miles from the town. This garden is comparatively new, but is becoming rapidly a most beautiful and interesting experimental station. Extensive plantings are being made which will add greatly to its attractiveness and usefulness.

The first trip made by us was to Castleton, the seat of the most interesting of the botanical gardens of Jamaica. We drove from Kingston, about nineteen miles, over a most picturesque road, the vegetation becoming more and more luxuriant as we approached the garden, where there is an average rainfall of about one hundred inches. A few hours only were spent at this time at Castleton, but later Professor MacDougal and myself returned for a stay of several days, during which we became better acquainted with the many attractions of this most beautiful garden. It is situated at an elevation of about six hundred feet, and contains a remarkable collection of palms and other tropical plants. Of the former there are about one hundred and fifty species, and among the other notable plants was a fine collection of cycads, comprising many magnificent specimens, which appear to thrive to perfection; screw pines, tree ferns, and many pretty epiphytic orchids, as well as innumerable showy flowering trees and shrubs, made the finest display we encountered anywhere. Of the flowering trees *Amherstia nobilis*, with its hanging clusters of gorgeous scarlet flowers, was, perhaps, the most beautiful; but among other showy trees were noticed a Lagerstrœmia, with big, lilac-colored flowers, and a Spathodea, whose flame-colored cups and deep green leaves formed a magnificent spectacle.

The country all about is very mountainous, and a trip to the higher regions yielded a number of most interesting ferns and liverworts, as well as many flowering plants not found on the lower levels.

A trip was made later to Blue Mountain Peak, the highest point in the island, rising over seven thousand feet above sea level. This excursion, which was taken in company with Mr. Fawcett, was in all respects a most enjoyable one. The trip was made from Kingston, and after the first nine miles was

done on horseback, as the mountain roads are not available for vehicles. The native ponies are very sure-footed, however, and the trip offers no hardships, and more than repays one, both scenically and botanically, for the trouble. The scenery is of the most magnificent character, with fine views in all directions. This is the principal coffee-growing district, and on all sides were extensive plantations, many of them very old. Here and there were the works for storing and curing the berry, great heaps of which could be seen in places spread out upon the concrete platforms, "barbecues," to dry in the sun.

We visited the Hill gardens, "Cinchona," where there are plantations of cinchona trees, whose cultivation, however, no longer is profitable. Most of the plantation lies about five thousand feet high, and here the conditions are favorable for the growth of many subtropical and temperate plants, as the temperature is never extreme.

In the neighborhood of Cinchona were found the finest collecting grounds for ferns met with anywhere. In the shady, moist ravines there was a profusion of fern growths far exceeding anything I have ever seen. The tree ferns, various species of Alsophila and Cyathea, were magnificent; some of them could scarcely have been less than forty feet in height, their graceful, slender trunks crowned with the exquisitely cut leaves looking like the finest lace overhead against the sky. The undergrowth was largely composed of a bewildering variety of ferns, from big Marattias and Alsophilas, with leaves ten or fifteen feet long, to tiny Hymenophyllums, looking more like delicate mosses than ferns. Other interesting plants were Danæa, several species of Gleichenia and Davallia, and many fine liverworts and mosses. A rather unexpected find was a Sphagnum, which occurred in large beds along the roadside in one place. The occurrence of Sphagnum, as well as other Northern plants, such as *Lycopodium clavatum*, *L. complanatum*, *Fragaria vesca*, blackberries, and buttercups, mixed with beautiful pink begonias, Gleichenia, and other tropical types, showed the meeting of the Alpine and lowland floras.

The ride from Cinchona to the summit, about two thousand feet above it, did not reveal any very marked differences in the

plants encountered, although at the summit itself the trees were somewhat dwarfed. Among the most characteristic trees of the higher altitudes was a Vaccinium, *V. meridionale* Sw., and *Podocarpus coriaceus* Rich. Tree ferns abounded, but were not so fine as those somewhat lower down.

From the peak fine views may be had in clear weather in both directions. On the north is the harbor of Port Antonio, and on the south that of Kingston. We did not enjoy the fine view very long, as a shower of rain came up which obliged us to descend sooner than we had expected, but not before we had time to get a good idea of the vegetation.

A most enjoyable trip was one made by the writer in company with the late Dr. Humphrey, in whose untimely death in Jamaica, shortly after our departure, botany has suffered so severe a loss. This trip was over the mountains from Port Antonio to Bath, the site of the first botanic garden established in Jamaica some hundred years ago, but now reduced to a fraction of its original area. It still contains some fine specimen trees, especially palms and Pandanus, but there are a number of other fine trees still remaining. The road over the mountains is a rough bridle path, which at the Cuna-Cuna pass reaches an altitude of about three thousand feet. It is proposed to make a carriage road, which will be, when complete, one of the most beautiful in Jamaica, as it passes through a most picturesque region, including the finest forests we saw anywhere. The whole district is one of very heavy rainfall and the vegetation wonderfully varied and beautiful. The road over the pass is through virgin forest of the most luxuriant description. Ferns in great variety abound, and in some places thickets of beautiful palms, *Euterpe oleracea*, formed a striking feature of the forest. These palms, with the tree ferns, large aroids, and epiphytic Bromeliads and orchids gave a thoroughly tropical aspect to the vegetation. There were numerous epiphytic orchids, but only a few in flower. Of these a yellow and brown Oncidium was most conspicuous, the great hanging panicles of flowers looking like a swarm of small butterflies. A great variety of showy Scitamineæ, Heliconia, Hedychium, Canna, and others were common, and among

the lower plants were several tropical liverworts, among them Dendroceros, Symphyogyna, and Monoclea.

The little town of Bath lies close to the base of the mountains, and, besides its ancient garden, is famed for its hot mineral baths. The town was formerly much more important than at present, and there are still some of the fine old trees left, planted by a former generation. Among these are grand specimens of the stately *Oreodoxa oleracea*, the finest of all the Jamaica palms. This tree, with its smooth, slender shaft a hundred feet in height and its crown of green plumes, is indeed one of the most beautiful of plants.

As may be gathered from the foregoing sketch, the flora of Jamaica is extraordinarily rich and varied. The presence of high, abrupt mountains results in extremely different conditions both of temperature and moisture, and this is evident in the very divergent character of the plants of the different sections of the island. As we have seen, the prevailing vegetation is distinctly tropical, and, as might be expected, related to that of the Central and South American mainland. Considering the size of Jamaica the number of indigenous palms is surprising. Of the strictly American types of plants the Bromeliads are the most noticeable, although the Cacti, Agaves, and Yuccas are represented. The Bromeliads occur in nearly all parts of the island, and form an important factor in the rich epiphytic flora. One of the most characteristic sights is a large cotton tree (Eriodendron) with its great horizontal branches covered with a mass of epiphytes, conspicuous among which are many Tillandsias and other bromeliaceous forms.

Of orchids the island has about sixty species, many of them epiphytes, most of which are not especially showy. Besides the Oncidium already mentioned, there are pretty Epidendrums, and an exceedingly brilliant little crimson species, *Broughtonia sanguinea*, was common in several localities. Of the terrestrial orchids in flower the finest were two species of Bletia, recalling our own Calopogon, and a magnificent Phajus, which is said to have been introduced from Asia.

The aroids are among the noticeable plants, many striking species being common. Several species of Philodendron are

exceedingly abundant, climbing high up the trunks of trees or clambering over rocks; Syngonium, closely resembling Philodendron, is also abundant, and species of Anthurium, Dieffenbachia, and other genera abound in the more moist localities. The floating *Pistia stratiotes* is a common inhabitant of ponds and quiet rivers.

Several species of Cacti are common, especially in the drier parts, where one columnar Cereus is often used for fences. One great night-blooming species, *C. triangularis*, almost covered the trees in places. Two species of Rhipsalis were common at various places visited.

Other striking plants were the innumerable lianas, draping and almost smothering the trees. Some of these were leguminous climbers, others Convolvulaceæ, Vitaceæ, Thunbergias, Allamandas, and a great many which there was not time to identify. Some of the showiest flowers seen belonged to these creepers. Many other interesting plants were noted, but those cited are enough to give some idea of the tropical character of the flora.

All the ordinary cultivated plants of the tropics grow with very little care, and many have become practically spontaneous. Fruit-growing has assumed great importance of late, and is becoming yearly more and more important.

Except the ferns and liverworts no very careful studies were made on the lower plants. Probably no region of equal extent in the world is richer in ferns than Jamaica. About five hundred species have already been described, and there are probably many more to be discovered, as very little collecting has been done in the more inaccessible parts of the island. The ferns comprise all the tropical types, the Hymenophyllaceæ alone being represented by some fifty species. The Cyatheaceæ include the tree ferns, Cyathea, Alsophila, Hemitelia, which are numerous and of very large size and wonderful beauty. Of the Marattiaceæ, *Marattia alata* and several Danæas are not uncommon in the higher mountains, and the Schizæaceæ comprise species of Schizæa, Lygodium, and Anemia. Gleichenias of several species are common and conspicuous ferns. The Ophioglossaceæ are scarce and none were encountered,

although several species belong to the island. Of the heterosporous ferns the only one met with was *Marsilia polycarpa*.

Several species of Selaginella and Lycopodium were common, and *Psilotum triquetrum* was encountered once, but is evidently rare.

The liverworts are comparatively scarce at the lower levels, but amazingly abundant and varied in the higher altitudes, where the ferns also reach their maximum development.

Algæ were less abundant than had been expected, and lack of time did not permit a careful study of this group. Owing to the very slight tide — only about one foot — very little collecting can be done from the shore, and we were not provided with apparatus for collecting in deep water. The most interesting forms noted were the marine Siphoneæ, Caulerpa, Halimeda, and others. Probably this group is well represented and would repay careful study. Fungi also were less abundant than might have been anticipated.

In considering the localities best fitted for the establishment of a laboratory, there is little question that the eastern part of the island offers much the best conditions, as here there is the maximum rainfall with the resulting luxuriant vegetation. Port Antonio, lying on the coast and being very accessible, as well as offering excellent living accommodations, is in many respects a favorable locality, but is rather too far from the higher altitudes and virgin forest. Bath is nearer to the latter and is fairly easy of access, but is seven miles inland.

The writer cannot close this sketch without acknowledging the many kindnesses shown us on our trip by every one with whom we came in contact. Through the courtesy of the director of the island railways, Mr. McKinnon, we were provided with passes over all the lines, and were also offered other help which lack of time prevented our accepting. The governor of Jamaica, Sir Henry Blake, and the authorities of the Institute of Jamaica also showed great interest in our plans and helped us in many ways. It is to Mr. W. Fawcett, however, that we are especially indebted, and to whom much of the success of our trip is due.

THE WINGS OF INSECTS.

J. H. COMSTOCK and J. G. NEEDHAM.

Chapter I.

An Introduction to the Study of the Homologies of the Wing-Veins.

It is the purpose of this series of papers to present a summary of what is known regarding the structure and development of the wings of insects, to give the results of some investigations in these fields made by the writers, and to indicate the value in taxonomic work of the characters presented by the wings.

As the growth of our knowledge naturally proceeds from a study of the obvious facts of nature to those that are more deeply hidden, it seems best to discuss first the structure of the wings of adult insects and to postpone for a time the study of the beginnings of wings. It will be necessary, however, to take up early in the discussion a study of the structure of the wings in those stages that immediately precede the adult stage, the pupæ of insects with a complete metamorphosis, and the nymphs of insects with an incomplete metamorphosis. It is in this field that we have the most to offer that is new.

Several writers have appreciated the fact that much light can be thrown on the problem of determining the homologies of the wing-veins by a study of the tracheæ that precede them in the wings of immature insects. The more important of the contributions that have been made to this phase of the question are those of Brauer and Redtenbacher[1] and of Spuler.[2] Still, comparatively little has been done in this direction.

This is doubtless due to the difficulties that have stood in the way of work of this kind. The tracheæ of the wings of pupæ and nymphs are often very delicate, and when filled with

[1] Brauer und Redtenbacher, Ein Beitrag zur Entwickelung des Flügelgeäders der Insecten. *Zool. Anz.*, 1888, pp. 443-447.

[2] A. Spuler, Zur Phylogenie und Ontogenie des Flügelgeäders der Schmetterlinge. *Zeit. f. wiss. Zool.*, Bd. liii, 1892, pp. 597-646.

the medium in which a wing is mounted for microscopic study they are usually invisible. It is not strange, therefore, that they have been studied so little. But in the course of our investigations we have devised a method of study of the wings of immature insects which renders the observation of the tracheæ in them a simple matter.

If a living pupa or nymph be placed in formol (4%) the tissues of the wings will be rendered translucent in a short time. In the case of very delicate insects only a few hours

Fig. 1. — Part of a wing of a pupa of *Corydalis cornuta*.

are required for this, but with larger ones with more opaque wings it is necessary to leave them in the formol for several days, or even for several weeks. While the formol renders the tissues translucent, it does not soon penetrate the tracheæ, which are, therefore, left filled with air, and appear as dark lines when the wing is examined with transmitted light. Just after molting some wings are translucent, but there are few so clear that a short stay in formol will not make them clearer.

In order to study wings prepared in this way, they are removed from the body and mounted in glycerine jelly, care being taken to cool the mount quickly so that the jelly will not

penetrate the tracheæ. In this way most beautiful objects can be prepared, which will show the minutest ramifications of the tracheæ.[1] Fig. 1 is a half-tone reproduction of a photograph of an object prepared in this way. This figure represents a small portion of a wing of a pupa of *Corydalis cornuta*.

Not only can the tracheæ that precede the wing-veins be studied in this manner, but, if the wing be taken at the right stage, the cuticular thickenings destined to form the wing-veins, as well as their corresponding tracheæ, if there be any, can be seen. Figs. 2 and 3 are half-tone reproductions of photographs of wings taken at this stage.

There is, however, one undesirable feature of preparations made in this manner; it is that after a time the cuticular thickenings become indistinct, and the glycerine jelly will penetrate the tracheæ, rendering all except the larger ones invisible. But as it is a very easy matter to photograph such preparations, and as a series of photo-micrographs are much more easily compared than a series of microscopic slides, this feature does not materially impede an investigation of this kind. Usually the cuticular thickenings show best as soon as a mount is made, while the tracheæ stand out more sharply twenty-four hours after mounting, because of the clearing effect of the glycerine jelly upon the cuticular parts. It is, therefore, frequently desirable to make, at different times, two or more photographs of the same specimen.

[1] In making mounts of this kind our usual procedure was to spread a drop of melted glycerine jelly on a slide and allow it to cool; then to dissect off the wings (generally under water), taking with them just enough of the thorax to include the basal attachments of the tracheæ; then to place these wings upon the solidified glycerine jelly on the slide; then to lower upon the wings a heated cover glass, causing the jelly to melt enough to envelope the wings; and then to cool the mount speedily on a cake of ice, a marble slab, or in a draught of cold air. Rapid cooling is imperative, for in melted glycerine jelly the tracheæ soon become filled, and the smaller ones are then invisible.

It is imperative, also, that the wings be handled with care. Being simple sac-like structures, the tracheæ are almost free within them, and a slight pinch with forceps in the middle of the wing may throw all of its tracheæ out of place. It is better to lift the wing by its thoracic attachments or upon a section lifter.

Not every pupal wing is fitted for this study. Just before molting, and especially just before the last molting, the wing becomes so crumpled within its old sheath that the course of its tracheæ can be followed only with difficulty. Much time can be saved by the selection of the paler individuals for study.

It is obvious that one who has learned the homologies of the principal tracheæ of wings can easily determine the homologies of the wing-veins of the adult by the study of wings taken in the stage of development shown by Figs. 2 and 3. It should be remembered, however, that the determining of the homologies of these tracheæ necessitates the study of a large series of well-selected types. One is not warranted in arriving at conclusions in this matter from the study of a few representatives of a single order of insects.

During the past year we have studied in the manner indicated the wings of representatives of nearly all of the more important groups of winged insects, and have made several

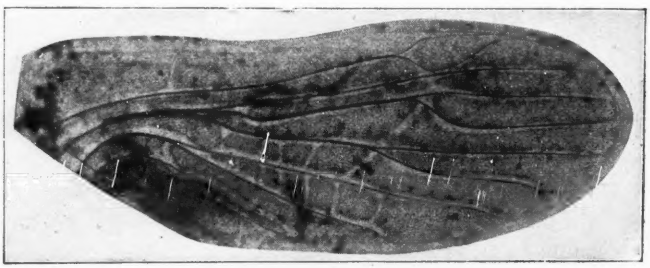

FIG. 2. — Fore wing of a nymph of Nemoura.

hundred photo-micrographs of them. We feel, therefore, that we have at hand sufficient data to warrant the conclusions regarding the homologies of the wing-veins that we purpose to offer.[1]

Although Figs. 2 and 3 will be discussed in detail in a subsequent chapter, we will give a few words of explanation here. These figures represent the wings of one side of a nearly mature nymph of a Nemoura, one of the genera of stone flies (Plecoptera). In making the preparations it was impracticable to remove all of the dirt adhering to the wings without danger of injuring them; this is often the case in preparing mounts of

[1] The most important gap in our series of observations is due to the fact that as yet we have been unable to procure pupæ of any of the Mecoptera. We would, therefore, be under great obligations to any one who would send us living pupæ of either Panorpa or Bittacus.

the wings of aquatic nymphs. The irregular blotches of dark color in the figures are due to this cause. The dark lines traversing the disk of the wing represent the tracheæ, and the pale bands the cuticular thickenings destined to form the wing-veins.

It will be observed that the principal veins are formed along the courses of tracheæ, while in most cases the cross-veins have no tracheæ within them. It will also be observed that the tracheæ extend in straight lines or in gentle curves, while in some cases the corresponding veins are much more angular.

It is evident from this that in the perfecting of a wing as an organ of flight the position of a vein in the adult may become

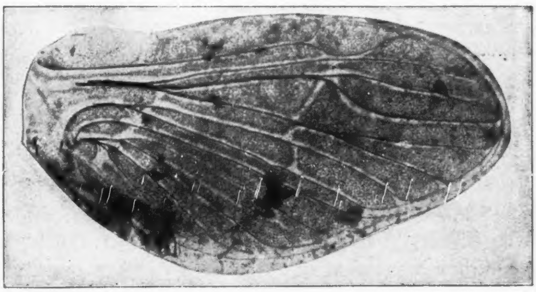

FIG. 3. — Hind wing of a nymph of Nemoura.

quite different from that of the corresponding trachea of the immature form. In other words, although there is no doubt that the courses of the principal wing-veins of primitive insects were determined by the position of the principal tracheæ of the wings, the wing-veins have been more or less modified to meet the needs of adult life; while at the same time the tracheæ of the immature wing, serving the purpose of respiration, and lying more or less free within the wing-sac, have not been forced to follow closely the changes in the cuticular thickenings of that sac.

The operation of this principle is shown only to a slight extent in the wings figured here. But when we study more highly specialized forms, it is seen that the divergence of these

two sets of structures is sometimes very wide, and must be taken into account in an interpretation of the characters presented by a wing.

While this increases the difficulty of determining the homologies of the wing-veins, it is often of great aid in taxonomic work, for it may afford an indication of the degree of divergence from a primitive type in the structure of a wing; and when a series of forms is studied the course of this divergence is often clearly indicated.

The figures also show that in some cases what appears as a single vein is formed about two closely parallel tracheæ. This is shown in the case of the bases of the second and third principal tracheæ, counting from the costal margin of the wing, the radial and medial tracheæ. This illustrates a fact of frequent occurrence, — that what appears to be a single vein may be formed by the coalescence of two primitive veins.

In these figures the tracheæ just mentioned, except one of them in the fore wing, appear not to extend to the base of the wing. This is due to the fact that in the preparations photographed the mounting medium had penetrated these tracheæ for a distance, rendering the basal portion of them invisible.

The figure of the hind wing illustrates also another way in which specimens may be injured during their preparation, and which may lead to a misinterpretation of them. In this wing the first branch of the first main trachea, the subcostal trachea, has been broken and moved out of place within the wing-sac. The normal position of this branch is well shown in the figure of the fore wing.

We will not go farther into the discussion of the technique of this method of study. Enough has been said to show that we have at hand a comparatively simple method of determining those questions of homologies of wing-veins that have sorely puzzled all investigators that have attempted to deal with them, and to indicate the nature of the material upon which we have based the conclusions that we purpose to offer in succeeding chapters of this paper.

Entomological Laboratory,
Cornell University, November, 1897.

EDITORIAL.

The Aim of the American Naturalist. — The thirty-second volume of the *American Naturalist*, which commences with the present number, will be the first entire volume to appear under the new management. It may not, therefore, be inappropriate at this time to state once more the motive which has induced us to assume control of the magazine.

Every enterprise that hopes to be successful must be conducted with some one definite aim in view. From the range of subjects covered by the *Naturalist* it may be supposed by many that the magazine is to be a kind of scrap basket for a miscellaneous lot of articles which, for one reason or another, have failed to find space in the journals of the special sciences to which they rightly belong. This is just what we most earnestly desire to avoid. We wish to select our articles so that the magazine shall have a definite character, with each department working in harmony with all the rest. What, then, is to be the basis of selection? What common point of view shall cement its diverse departments into a harmonious whole?

There was a time, hardly antedating the foundation of this journal, when one man might be equally eminent as a zoologist, a botanist, and a geologist. Many of the most distinguished names in science are borne by men whose activities ranged over all of these broad fields. But the conditions have been so changed by the rapid accumulation of knowledge during the last half-century that in order to attain any success a man must devote his attention to a narrow field; and, instead of becoming naturalists in the broad sense of the term, we see men becoming lepidopterists, coleopterists, ornithologists, embryologists, and the like, devoting their entire attention to one small group of animals or plants, to a narrow line of investigation in morphology or physiology, or studying exclusively some small class of phenomena in geology or mineralogy. Instead of the general scientific journals and societies of natural history of former times, these conditions have called into life and elevated to the highest prominence societies and journals dealing with the special problems of restricted lines of research. Such conditions obtain to-day, and must continue to influence the course of investigation so long as unknown facts remain to be discovered.

But can we not see already the dawn of a new era in natural science, brought about by this very multiplicity of independent researches and vast accumulation of material? Generally speaking, the obvious facts of natural science have been discovered, and investigation is trending away from them toward the deeper, more remote, and more fundamental phenomena. Students following these deeper lines of research sooner or later find themselves on the border where their scientific field touches their neighbor's. The morphologist who seeks to explain the causes of development soon finds himself involved in questions of physiology. Physiologists, on the other hand, in studying the functions of the nervous system, for example, have found it possible to draw important conclusions from data furnished by morphology. The geologist supplies the biologist with information concerning the conditions that have influenced the geographical distribution of organisms, and learns from him in turn what organisms have to teach as to the nature of the environment in which strata have been deposited. And so it is throughout all the related sciences. A good example of this tendency is furnished by the program of the American Morphological Society, which is holding its meeting as we go to press. We notice such titles as the following: "Grafting Experiments upon Lepidoptera," "The Effect of Salt Solutions on Unfertilized Eggs of Arbacea," "Some Activities of the Polar Bodies of Cerebratulus," "The Reaction of Amœba to Light of Different Colors and to Rœntgen Rays." Surely we may expect these papers to contain as much physiology as morphology.

A movement seems to be well under way toward a closer union of the natural sciences based not upon superficial observations and poorly grounded speculations, but upon a deeper insight into the real facts. It is the purpose of the *American Naturalist* to aid and encourage this movement. We desire that our pages afford a common meeting-ground where the morphologist, the physiologist, the zoologist, the botanist, the anthropologist, the palæontologist, the geologist, and the mineralogist may meet to discuss the problems in which they have a common interest. But it is not merely articles dealing in broad generalities that we want. Accounts of the most minute investigations will be cordially welcomed, if only the results are shown to have some significance from our point of view.

Of course, ultimately, all human knowledge is a unit, and no fact lacks significance; but we have no ambition to cover such a field. How, then, shall we define our province?

May it not be possible to regard the earth and its inhabitants as a unit? Then the problem would be to describe the various parts of this unit and to explain their relations to one another. While the solution of this problem is too vast an undertaking for any one man or any generation of men, may it not be legitimate to adopt it as the final purpose of a journal which is intended to represent the great body of naturalists in this country? It seems to us that this is a legitimate ideal of attainment, and one which, if kept steadily in view by editors and contributors, will afford that unity of purpose which is essential to success.

But in order to be truly representative and to attain the highest success, we need the coöperation of every naturalist in America. We are glad of your subscriptions, but we especially desire your contributions. To every one who has anything interesting to say we extend a cordial invitation to use our columns. If the editors are allowed to choose from the best that is produced, they will find no difficulty in issuing a magazine that Americans may be proud to call the *American Naturalist.*

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

Report of the Bureau of Ethnology.[1] — In the introduction to the administrative report Major Powell outlines more definitely than in the preceding volume his classification of ethnological activities. "The great science of demonomy," or the science of humanity, is divided into five categories : (1) esthetology, (2) technology, (3) sociology, in the sense of the science of government, (4) philology, with enlarged definition, (5) sophiology, the science of opinions. It is believed that the Bureau has organized and defined "the demotic sciences in such manner as to yield a definite basis for a scientific classification of the races and peoples of the earth."

The director announces that the vast collection of information obtained from personal research, manuscripts, and published literature concerning the Indians is to be published in a series of bulletins corresponding with the aboriginal stocks, under the designation "Cyclopedia of the American Indians." The subjects of the four accompanying papers are found in the pueblo region of the Southwest, in Yucatan, and in Peru.

The first of the two memoirs upon "extra-limital" subjects is not only of general, but also of comparative interest, since it aids in demonstrating the unity of aboriginal American culture. The conclusion is reached by Professor McGee that the operations of trephining were performed by persons of the same culture grade as the well-known "medicine men" of this continent, though but one case of trephining is thus far known in North America. In a collection of about one thousand crania two per cent were found to have been trephined, several more than once. Dr. Muñiz states that all the specimens pertain to a period at least two hundred years anterior to the discovery ; they are from various and widely separated pueblos. No trephined crania have thus far been discovered at the necropolis of Ancon. Post-mortem trephining was not practiced, and no amulets of human bones have been found in Peru. The origin and development of this dangerous practice is discussed, and the methods

[1] *Sixteenth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution*, 1894–95, by J. W. Powell, Director. Washington, Government Printing Office, 1897.

classed according to culture grades. Comparison is made with the customs of the South Sea Islanders and the Kabyles, among whom trephining has long been practiced with a heroic exhibition of fortitude and an even greater recklessness of consequences than among the Peruvians. The South Sea Islanders hacked and scraped the skull with stone and shell, and covered the wound with plates of cocoanut. The operation was performed in some cases for the relief of simple headache. The Muñiz series contains but six crania which indicate a therapeutic motive; these operations were performed to relieve traumatic lesions, and all resulted fatally.

The second paper, "The Cliff Ruins of Canyon de Chelly, Arizona," is accompanied by a map which shows the extent of the pueblo region within the limits of the United States. The Canyon de Chelly is located near the center of an area which embraces nearly all of Arizona, eastern and central Utah, western New Mexico, and a small portion of southwestern Colorado.

Mr. Mindeleff's observations show that the cliff dwellers were Indians, and not a race distinct from the neighboring tribes. The cliff houses were erected in easily defended situations, where ledges afforded foundations and roofs, and where suitable blocks of stone for the walls were abundant. The same people also possessed pueblos near their unprotected agricultural lands. Gradations are found from the cliff to the pueblo type of domicile.

Dr. Cyrus Thomas, in a publication entitled *The Maya Year*, has shown that the year recorded in the Dresden codex consisted of eighteen months of twenty days each. The origin and signification of the symbols in the Maya, Tzewtal, Quiche-Cakchiquel, Zapotic, and Nahuatl, representing each of these twenty days, form the subject of the paper entitled "Day Symbols of the Maya Year." The Maya scribes had not reached that advanced stage where they could indicate each letter sound by a glyph or symbol; yet the characters used were to a certain extent phonetic. The symbols were not true alphabetic signs, but syllabic, in some cases ideographic, or in others simply abbreviated pictorial representations.

The memoir by Dr. J. Walter Fewkes on "Tusayan Snake Ceremonies" deals with a modification, produced by peculiar environmental conditions, of the serpent cultus which extended from the St. Lawrence to Peru. The ceremonies observed at the Hopi villages of Oraibi, Cipaulovi, and Cuñopavi are described in detail, and the conclusion is reached that "the worship of a great snake plays no part, but the dance is simply the revival of the worship of the Snake

people, as legends declare it to have been practiced when the Tîyo was initiated into its mysteries in the world which he visited." "I am inclined to believe that the snake dance has two main purposes, the making of rain and the growth of corn, and renewed research confirms my belief, elsewhere expressed, that ophiolatry has little or nothing to do with it."

The Import of the Totem.[1] — Miss Fletcher's studies have been aptly characterized as "sympathetic and thorough," and the present paper fully demonstrates the truth of the observation. Within the limits of a few pages is given a remarkably clear and concise account of the idea of the totem, one of the most obscure and perplexing subjects with which the student of American ethnology has to deal.

The totem is based upon the Indian's belief concerning nature and life, and it is only through an explanation of his customs and practices, a knowledge of his rites and ceremonies, that we may come to know what this belief is.

There are two classes of totems among the Omahas: (1) personal, belonging to the individual, and (2) social, that of societies and gentes. The personal totem is obtained by means of a puberty rite in which the youth fasts until he sees or hears in a dream or vision some animal or other form. This thing becomes the special medium through which he can obtain supernatural aid. It is his duty to seek and slay the animal seen in his vision ('in cases where the vision has been of no concrete form, symbols are taken to represent it') and preserve some part of it. This amulet represented the power of the whole class to which it belonged, a conception growing out of the anthropomorphic projection of man's characteristics upon all nature and the belief in the continuity of life, "making it impossible for the part and the entirety to be disassociated."

"The totem's simplest form of social action was in the religious societies, whose structure was based upon the grouping together of men who had seen similar visions, . . . blood relationship was ignored." "In the early struggle for existence, the advantages accruing from a permanent kinship group, both in resisting aggression and in securing a food supply, could not fail to have been per-

[1] *The Import of the Totem: A Study from the Omaha Tribe.* By Alice C. Fletcher, Thaw Fellow and Assistant in Ethnology, Peabody Museum, Harvard University. A paper read before the Section of Anthropology of the American Association for the Advancement of Science at the Detroit meeting, August, 1897. Salem, The Salem Press, 1897.

ceived; and, if the people were to become homogeneous and the practice of exogamy continue, some expedient must have been devised by which the permanent groups could be maintained and kinship lines be defined. The common belief of the people, kept virile by the universal practice of the rite of the vision, furnished this expedient." "Social growth depended upon the establishment of distinct groups, and the one power adequate for the purpose was that which was believed to be capable of enforcing the union of the people by supernaturally inflicted penalties."

There were ten gentes in the Omaha tribe; exogamy prevailed, and descent was traced only through the father. "Each gens had its particular name, which referred directly or symbolically to its totem, which was kept in mind by the practice of tabu." The office of the totem in the religious societies, in the gentes, and the tribe is described, and the paper closes with a discussion of the linguistic evidence as to the import of the totem.

FRANK RUSSELL.

GENERAL BIOLOGY.

A Study in Heredity.[1] — For the student of heredity no domestic animal is of greater interest than the American trotting horse and his brother, the pacer. The two are closely related; their development has been rapid and has taken place mainly during the latter half of the present century, and the records of ancestry and of speed, which have been kept accurately, give a measure of the inheritance of variations in a large number of correlated parts. It is, therefore, a real service to biologists, as well, no doubt, to breeders, that Mr. A. J. Meston is doing in bringing together in one work the main facts concerning the ancestry of the best trotters and pacers.

The first part of this work, dealing with the descendants of the horse known as Rysdyk's Hambletonian 10, is what we have now under review. That the remaining parts will not be long forthcoming is to be hoped, for each part will gain in value in proportion to the completeness of the whole.

The pamphlet before us opens with a list of the common sources of 2:10 speed arranged chronologically. Then follows an introduc-

[1] A. J. Meston, *The Common Sources or Main Taproots of 2:10 Trotting and Pacing Speed. Rysdyk's Hambletonian 10 (Complete).* Pittsfield, Mass. Published by the author, 1897. 32 pp.

tory chapter, containing, among other things, a very complete description of Hambletonian, with measurements and his pedigree. The main body of the work is a list of all the descendants of Hambletonian that have trotted or paced in 2:10 or lower. The date of birth, best record, and the date when it was made are given for each horse, and also the name of each ancestor in the Hambletonian line with dates and records. The whole is cleverly arranged, so that, with the aid of the index, the entire pedigree of each horse can be traced easily as far as this particular line of descent is concerned. Following the list are a note on the transmission of acquired speed, remarks on the dual inheritance of the capacities for trotting and pacing, and several interesting tables.

Hambletonian was the sire of 1287 colts. The American Trotting Register Association's *Year Book* for 1896, from which Mr. Meston has gathered a large part of his facts, credits Hambletonian with being the sire of 40 trotters (records 2:17½ to 2:30), 148 stallions that have sired 1398 trotters and 155 pacers, and 80 mares that have foaled 104 trotters and 8 pacers. "At the close of 1896 the *Year Books* have listed altogether 12,945 trotters that have made records in 2:30 or lower and 4302 standard pacers, — a grand total of 16,207 trotters and pacers with standard records."

"It is safe to say," the author remarks, "that somewhere between 80 and 90 per cent of the whole number 'carry the blood' of Hambletonian 10."

In view of these facts, the ancestry of Hambletonian is of great interest. His descent is traced through three lines, one paternal and two maternal, back three and four generations, to Messenger, an English thoroughbred imported to Philadelphia in 1788. This horse is remarkable because of the trotting instinct which almost invariably appeared in his half-bred foals, and which was strongly transmitted by his thoroughbred sons. Moreover, the paternal grandam and maternal grandsire of Hambletonian were natural trotters, not related to Messenger nor to one another. It is not surprising, therefore, that Hambletonian should be the founder of a race of trotters. There are also a large number of pacers among his descendants, and it is a significant fact that there were a few pacers among the foals of his sire, Abdallah 1.

The intensity with which the instincts for trotting and pacing and the capacity for speed have been transmitted through the descendants of Hambletonian is shown by the fact that of the 54 trotters and 146 pacers of all breeds who have made records of 2:10 or lower, 50

trotters and 122 pacers trace their descent in one or more lines from this horse. The preponderance of pacers is accounted for by the greater swiftness of their gait. Because of the inherently greater speed of the pace over the trot, it will be necessary, in order to compare the speed attained by a pacer with the speed of his trotting ancestors or brothers, to establish some ratio by which a trotting record may be transmuted to its equivalent pacing record, in the same way that Galton has transmuted female stature into its male equivalent in his discussions of the statistics of human measurements. This will require the comparison of a large number of individuals.

In the meantime, wishing to gain some idea of what this ratio may be, we have compared the 54 best pacers with the 54 2:10 trotters. Comparing each horse of one class with the horse of the corresponding grade in the other, there is found to be an average difference of 2⅓ seconds, the maximum being 3¾ seconds and the minimum 1¾ seconds. It is interesting to note in this connection that in the case of one horse in our list that has made fast records in both classes the difference is not more than the above maximum, the pacing record of Jay-Eye-See being 2:06¼, and his trotting record 2:10. If this difference represents the gain in speed which a horse equally gifted in both gaits would make in pacing, then all horses who can trot within 2:12½ should be classed with the 2:10 pacers. At any rate, it is unfair to compare 2:10 trotters with 2:10 pacers, and for this reason the tables on pages 27 and 28 are misleading.

The author points out another source of error which arises from the introduction of the bicycle sulky with pneumatic tires in 1892. But, allowing for errors due to bicycle sulkies, improved tracks, and more experienced trainers, we can see a gradual increase of trotting and pacing speed in successive generations. How much of this improvement is due to the inherited effects of training, and how much to selection and combination of favorable variations in breeding? The list shows that a number of stallions and mares, after having been trained to fast records, have got foals that have made fast records. But there is no evidence that a line of trained ancestors is more successful in producing speed than a line of untrained ancestors, or a line of mixed trained and untrained ancestors. For example, of the 122 pacers in the list only 8 have a parent or grandparent that has paced in 2:10 or trotted in 2:13. None of the 50 trotters has a parent with a 2:10 record. In the list of trotters both parents are given in 22 cases. Both parents have a record in only 2 cases; in 13 cases one parent only has a record; and in 7 cases neither

parent has a record. This list of 7 fast trotters whose parents have no record is headed by Alix (2:03¾), and if extended would include Maud S., St. Julien, and Goldsmith Maid.

With only the lines of descent that happen to be traceable to Hambletonian, we have not sufficient data for any very extensive generalizations. But what we have indicates that variations in speed and their inheritance follow the same laws that Galton [1] has shown to apply to stature, color, and other fortuitous variations in man and other organisms. A horse in the 2:10 class is, as a rule, the single exceptional son or daughter of comparatively mediocre parents of good family. The largest number from any one parent is six, foals of Altamont, who has a wagon record of 2:26¾. But Altamont is a grandson of Abdallah 15, who was the sire of Goldsmith Maid (2:14), and who counts among his descendants Alix (2:03¾), Flying Jib (2:04), and John R. Gentry (2:00½). The importance of heredity in the production of speed is indicated very clearly by an examination of the pedigrees. Thus, Alix (2:03¾) is descended not only from Abdallah 15, but also by two lines from Harold, a son of Hambletonian, who is the sire of Maud S. (2:08¾). John R. Gentry (2:00½) and Joe Patchen, who paced this season in 2:01½, have a common ancestor by separate lines in George Wilkes; and Nancy Hanks is a granddaughter of Dictator, the sire of Jay-Eye-See, who has paced in 2:06¼ and trotted in 2:10. The author expresses very strongly the opinion, which seems to be borne out by the facts, that the capacities for pacing and for trotting are heritages which, like the light and dark colors of the eye,[2] are, as a rule, mutually exclusive, and that the development of either of these, as well as the capacity for speed, is dependent more upon selection of parents by the breeder than upon the education received by the foal from the trainer.

ZOOLOGY.

Weed's Life Histories of American Insects.[3] — This little work is evidently intended to meet in part the need of popular handbooks of nature study, and it does it in an admirable manner. It consists

[1] Francis Galton, *Natural Inheritance.*

[2] Galton, *loc. cit.*

[3] *Life Histories of American Insects,* by Clarence Moores Weed. New York, The Macmillan Company. 8vo, 272 pp., with illustrations. $1.50.

of a series of short essays on the life history of a number of our more common insects. The matter is handled in a simple and straightforward manner, and is well illustrated by figures in the text and by several full-page plates. Although largely a compilation, it is written by one who has done much original work in this field; hence the accuracy of its statements can be depended upon. While the entomologist will find in its pages comparatively little that is new, the amateur and the teacher who is trying to interest young people in what is going on around them will be able to gain much help from it.

J. H. C.

Weed's Stories of Insect Life.[1] — This book is similar in its purpose to the preceding, and resembles it in its method of treatment of the subject; but it is intended to be used by those who teach very young pupils. Such teachers will find it a helpful book.

J. H. C.

BOTANY.

North American Lemnaceæ.[2] — It cannot be doubted that the high character of the late Dr. George Engelmann's contributions to botany is largely due to the judicious concentration of his energies. No other American botanist of such wide general experience has so carefully restricted his published researches to the intensive examination of a few very difficult families and genera. Thus it was that Dr. Engelmann laid a sure foundation for a satisfactory classification of groups like Cactaceæ, Cuscuta, Juncus, Agave, Yucca, Lemnaceæ, and Alismaceæ. In consideration of this fact, the present director of the Missouri Botanical Garden could not have acted more wisely than in devoting so large a part of the present energies of his institution to the completion of work so well begun by his illustrious predecessor. Thus the recent reports of the Garden contain a series of valuable papers upon Yucca, Agave, Alismaceæ, etc., which, although based in part upon the collections and previous work of Engelmann, lose none of their originality on that account, but only

[1] *Stories of Insect Life*, by Clarence Moores Weed. Boston, Ginn and Company. 8vo, 54 pp., with illustrations.

[2] "A Revision of the American Lemnaceæ Occurring North of Mexico," by Charles Henry Thompson. Advance separate from the *Ninth Annual Report of the Missouri Botanical Garden*, issued Nov. 1, 1897. 8vo, 22 pp., 4 pll.

gain in worth in proportion as their originality begins at a higher plane and is built upon a surer foundation than could have been the case in other groups.

To this suite of useful papers Mr. C. H. Thompson has just added a revision of the North American Lemnaceæ. These diminutive aquatics, popularly called duck meats, include the most minute flowering plants. While from their peculiar structure they have long been familiar examples of such morphological phenomena as phylloidal stem, vegetative reproduction, reduction of floral structures, etc., their systematic interrelationship and geographic distribution have been, notwithstanding the critical treatises of Hegelmaier and Engelmann, but imperfectly understood. Mr. Thompson's paper is the first upon its peculiar field, since no previous monograph has at once covered and been restricted to North America.

While Engler in the *Natürlichen Pflanzenfamilien* reduces Wolffiella to a subgenus of Wolffia, Mr. Thompson follows Hegelmaier in recognizing four genera in the family, namely, Spirodela, Lemna, Wolffia, and Wolffiella, but rearranges them so that Wolffiella may stand next Lemna. No change is made in the North American Spirodela (represented by the common *S. polyrrhiza*), but a new South American species of somewhat doubtful identity and remarkably dissevered range is added to the genus. In Lemna the recognized North American species are *L. gibba*, *minor*, *trisulca*, *perpusilla* (with var. *trinervis*), *cyclostasa*, and *minima*. By the name *L. cyclostasa* (Ell.) Chev. is designated the plant which has for some years been known as *L. valdiviana* Phil., since the latter species, as the author believes, is identical with the *L. minor* var. ? *cyclostasa* of Elliott's *Botany of South Carolina and Georgia*. It is a pleasure to see that the range of this species, unaccountably incomplete in Britton and Brown's *Flora*, is duly extended to the three southern New England states. In Wolffiella three North American species are recognized; namely, *W. floridana* (*Wolffia gladiata*, var. *floridana* J. D. Smith), *W. oblonga*, and *W. lingulata*. Of Wolffia there are also three species credited to the continent, — *W. papulifera* (a new species from Missouri, discovered by Bush), *W. punctata*, and *W. columbiana*.

Mr. Thompson's descriptions are clear and ample, and the copious outline illustrations, which are of his own drawing, are satisfactory. His observations upon the "resting stages" (Hegelmaier's *Wintersprosse*) are worthy of mention, and above all the careful citation of synonymy and enumeration of *exsiccati* make the paper a very welcome contribution to American systematic botany. B. L. R.

The Oxford Herbarium. — A little pamphlet of twenty pages,[1] prepared by Mr. Druce, the curator of the Fielding herbarium, gives some interesting statistics of the important collections of Oxford, which commence with a set of 300 specimens collected by the Italian, Gregory of Reggio, in 1606, and contain such historic herbaria as that of the Bobarts, Morison, Du Bois, Sherard, Shaw, and Sibthorp of the last century, and a host of more modern collections. While in an introduction to the pamphlet Professor Vines states that it cannot be hoped to accumulate at Oxford collections to rival those of Kew or of the British Museum, those already brought together are seen to number hundreds of thousands of sheets, and the aim is stated to be to render the Oxford herbarium as complete as possible in plants representing the flora of Europe and the adjacent Mediterranean region. T.

Botany at Geneva. — To the numerous publications devoted wholly or in part to botany which have clustered about the long-time home of the De Candolles is now added another, the *Annuaire du conservatoire et du jardin botanique de Genève*, edited by Dr. John Briquet, who also edits the excellent *Bulletin du laboratoire de botanique générale de l'université de Genève.* The new *Annuaire*, which appears as the official organ of the two botanical institutions of the city of Geneva, is intended to constitute each year a volume of from 130 to 250 pages, giving information as to the condition of the garden, progress made, and the growth and scientific utilization of the collections, as well as original articles based wholly or in part on the material of the conservatory and garden.

The first volume,[2] which has recently appeared, contains an interesting report on the garden and the Delessert herbarium for the year 1896, two seed lists, and the following scientific papers: Crépin, a revision of the roses of some old Swiss herbaria; Arvet-Touret, a revision of the Hieracia of the herbarium of the younger Haller; an account of new or little-known species of the same genus, chiefly of the Delessert herbarium; and a description and plate of Crepidopsis, a new genus of Mexican composites related to Hieracium (based on Pringle's No. 1654, of the year 1888); and Kränzlin, a description of two new species of Habenaria, respectively from Java and the Philippines. T.

[1] *An Account of the Herbarium of the University of Oxford.* Oxford, The Clarendon Press, 1897. Price, sixpence.

[2] *Annuaire du conservatoire et du jardin botanique de Genève.* 1re année. Genève, Georg et Cie., 1897. 143 pp., 1 pl. 5 francs.

GEOLOGY AND PHYSICAL GEOGRAPHY.

Recent Works. — A fifth edition of Hann, Hochstetter, and Pokorny's *Allgemeine Erdkunde* is in preparation; Part I, *Die Erde als Ganzes, ihre Atmosphäre und Hydrosphäre*, by J. Hann, of Vienna, having been issued last winter; Part II, *Die feste Erdrinde und ihre Formen*, by E. Brückner, of Berne, being just received; and Part III, *Pflanzen- und Tierverbreitung*, by A. Kirchhoff, being in preparation (Tempsky, Prag). The two parts now issued are distinct enlargements of the original work. They may be characterized as concise, thorough, and correct. There is, unfortunately, no work in English that can be compared to them in these respects. A teacher or student wishing a trustworthy book of reference cannot do better than place this work by his side.

The Library of Geographical Handbooks, edited by Professor Ratzel, includes no volume more noteworthy than the *Klimatologie* by Dr. Hann, the first edition having appeared in 1883, and then at once taking the position of a standard work of reference. A second edition is now issued in three volumes (Stuttgart, Engelhorn), the liberal increase in size permitting the addition of new data and the introduction of footnote references, which were wanting and greatly missed before. An earlier volume in the series was the *Morphologie der Erdoberfläche*, in two volumes, by Prof. A. Penck, of Vienna, which may be fairly characterized as the most important geographical handbook of recent years. It is particularly valuable in its brief historical reviews of the development of various topics and in its rich references to sources.

A. de Lapparent's *Leçons de Géographie Physique* (Paris, Masson, 1896) deserves mention, even if somewhat belated. It is written in a more readable style than the books above mentioned, and should not be measured by comparison with them, but rather on its own standard of attractive presentation. It is also notable as marking a distinct advance towards a rational, genetic treatment of land forms. The intending scientific visitor to Europe will find it of much value as a companion.

American teachers interested in the position of general geology in Europe will find a thorough presentation of the science in Prof. H. Credner's *Elemente der Geologie* which now appears in an eighth edition, twenty-five years after its first publication (Leipzig, Engelmann). It is a stout volume of 797 pages, of which the last 45 are devoted

to an index. The chief headings are petrographical, dynamic, structural, and historical geology, over half the volume being given to the last. Each chapter opens with a brief list of references to sources. Illustrations are numerous, those of fossils being the most elaborate.

The first volume of *La Face de la Terre*, a translation under the competent direction of E. de Margerie of Suess' famous *Antlitz der Erde*, is just received. (Colin, Paris. 835 pp., many figures.) There is no other book to which the advanced student can turn for so many applications of what he has learned in geology, for here is given a broad geological view of all explored lands. The asymmetrical structure of mountain ranges is the chief theme of this volume. The translators have added numerous supplementary paragraphs, indicated by brackets, and have brought the references to geological sources down to the present year. Any one wishing to strengthen his geological library in the direction of the structural geology of the world can hardly do better than order all the works here referred to.

Tarr's *First Book of Physical Geography* (Macmillan, 1897) follows his *Elementary Physical Geography* (1895). The second volume was prepared because many teachers who wish to give instruction in the "new physical geography" are unable to use the first volume; this statement revealing the peculiarly insufficient understanding of the subject that the teachers gained when they were scholars. The *First Book* attempts rather too much in its astronomical and geological chapters, and goes further into physics than is necessary in the pages on the atmosphere. It is at its best when presenting the features of the land; but here, as is often the case, it gives relatively greater prominence to process than to form, and as a result withdraws the chief attention of the student from the prime object of geographical study. It is, nevertheless, a valuable addition to our school literature, and might easily have been more valuable if a carelessness of style and statement here and there had been avoided.

SCIENTIFIC NEWS.

The German Society of Naturalists and Physicians will hold its meeting next year at Dusseldorf. Professor Waldeyer, of Berlin, will occupy the presidential chair.

Many readers may be interested to learn that the *Journal of the Boston Society of Medical Sciences* has been enlarged and is now the medium for the publication of the abstracts of work carried on in Harvard Medical School, the Biological Laboratories of the Massachusetts Institute of Technology, and the Massachusetts General and the Boston City Hospitals. The journal is issued ten times a year, and the subscription price is $2.00.

The British Museum has just acquired the collection of vertebrate fossils from the pliocene forest-beds of Norfolk, made by Mr. A. C. Savin. It contains about 1900 specimens, embracing many of the types of Newton, Adams, and Lankester.

Among the most interesting of recent items of news are the items concerning the expedition of the Sydney Geographical Society to the Ellice Islands to study the structure of a coral reef. The drill was sent down to 557 feet. Down to 487 feet the results were inconclusive, but beyond that point they strongly favor Darwin's theory; but the matter cannot be settled until a microscopic examination of the cores is made. The boring is being continued, and may be carried down to 1000 feet.

The Albany Museum at Grahamston, South Africa, is to have a new building two stories high, measuring 150 feet in length by 60 in breadth.

Professor Gundelfinger, of the Technical High School at Darmstadt, receives the gold medal for merit from the Academy of Sciences at Munich for his botanical researches.

At the session of the Académie des Sciences held at Paris, Dec. 13, 1897, the Cuvier Prize of 1500 francs was awarded to Prof. O. C. Marsh, of Yale University. This prize is "awarded every three years for the most remarkable work either on the Animal Kingdom or on Geology." The Cuvier Prize hitherto has been given to only

two persons in this country, Agassiz and Leidy. The former, however, was a native of Switzerland, where the special work was done for which his prize was awarded.

The collection of fossils made by Mr. W. E. Gurley, late state geologist of Illinois, is for sale. Besides duplicates and unclassified material, it contains over 14,000 specimens duly labeled.

René Sand has an interesting review of the marine zoological laboratories of the world in the October number of the *Revue de l'Université de Bruxelles.* He enumerates those of Ostend, Concarneau, Arcachon, Sebastopol, Naples, Roscoff, Wimereux, Penikese, Luc-sur-Mer, Trieste, Helder, Kristineberg, Villefranche, Solovetsky, Banyuls, St. Andrews, Granton, Tarbert, Puffin Island, Woods Holl, Misaki, Marseilles, Dunbar, le Portel, Plymouth, Copenhagen, Tamaris, Rovigno, Tatihou, Port Erin, Helgoland, Bergen, Jersey, False Bay, Tromsö, Drobak, Kiel, Flöderig, Millport, Liverpool, Bologna, Dieppe, les Sables d'Olonne, Santander, Cette, Messina, Alger, Newport, Palo Alto, and Cold Spring Harbor. The list includes those in operation as well as those abandoned, but fails to include the laboratories at Annisquam, Fort Wool, Beaufort, and the stations of the Johns Hopkins University in the West Indies.

During the past summer there have been a number of scientific expeditions sent out by various institutions. We have already alluded in these pages to the misfortunes of the zoological expedition sent by Columbia University to Puget Sound and Alaska, and the more disastrous Jamaica laboratory of the Johns Hopkins University. Columbia University also sent out an expedition for fossils to Colorado and Wyoming, under the direction of Prof. Henry F. Osborn, while a Princeton University party, under Prof. William Libby, visited New Mexico. New York University students, directed by Prof. Charles L. Bristol, made large collections in the Bermudas. The University of California sent an archæological expedition to the Santa Catalona Island, off the coast of southern California, while the ethnological party of the American Museum of New York, under the direction of Dr. Franz Boas, made large collections among the tribes of British Columbia. Cornell University had two parties in the field. One studied the geology of the Catskills, while another visited Colorado. A party of Stanford University students accompanied President Jordan to the Pribilov Islands and made large collections there, while others continued the work at Monterey. Prof. Frederick Starr, as a

representative of the University of Chicago, made ethnological studies and collections in Mexico, while the University of Pennsylvania had collectors at work in Peru. The Princeton expedition, under the charge of Mr. J. B. Thatcher, returned, after several years' stay in Patagonia, with abundant collections, and almost immediately Mr. Thatcher returned with another party to continue the explorations.

The British *Journal of Microscopy and Natural Science*, the organ of the Postal Microscopical Society, has been discontinued, after an existence of sixteen years, because of inadequate financial support.

Prof. Wesley Mills, of McGill University, has been granted leave of absence for a year, which he will spend abroad.

The Reale Accademia dei Lincei of Rome has elected Profs. B. Grassi and G. Fano to the section of zoology and morphology; Profs. H. Kronecker and O. Schmiedeberg, foreign associates in physiology; and Prof. A. Gaudry, foreign associate in geology and palæontology.

The thirteenth annual meeting of the Kansas Academy of Science was held October 27–29 at Baldwin, Kan., in the building of Baker University. Thirty-five communications were presented. Professor Williston, as president, gave an address on Science and Education.

The International Congress of Zoology meets in Cambridge, England, Aug. 23, 1898, under the presidency of Sir William Flower. All communications, requests for circulars, etc., should be addressed to the Local Secretaries, International Congress of Zoology, The Museums, Cambridge, England.

Dr. Rudolf Heidenhain, professor of physiology in the University of Breslau, died October 13, at the age of sixty-three. He was born in Marieneverder Jan. 29, 1834, studied at Berlin, Königsberg, and Halle, and was called in 1859 to the chair, which he held until his death. His work extended over all aspects of chemical and histological physiology, and was especially brilliant in its discourses relating to the action of glands, the effects of drugs, and upon lymph formation.

Dr. Andreas Petr. von Semenow has resigned his position as conservator of the zoological collections of the Academy of Sciences of St. Petersburg.

Adalbert Geheeb, the student of mosses, has removed to Freiburg, i. B. His address is 39, Göthestrasse.

Prof. A. de Lapparent, the mineralogist, has been elected a member of the Academy of Sciences of Paris.

Dr. O. F. von Möllendorf, the conchologist, has removed from Manila to Kowno, Russia.

Sir Frederick McCoy, professor of natural history in the University of Melbourne, has resigned.

Prof. Hans Molisch, of Prague, has gone to Buitenzorg, Java, for the winter.

Dr. Hugo de Vries has decided not to accept the call to the chair of botany at Würzburg left vacant by the death of Sachs.

Dr. O. Loew, of the botanical department of the University of Tokyo, has resigned on account of ill health.

We notice the following appointments and advancements of naturalists: Dr. Nikolaus von Adelung, of Geneva, conservator of the zoological collections of the Academy of Sciences of St. Petersburg. — Raphael Blanchard, professor of medical natural history in the medical faculty of Paris. — Dr. A. Borgert, privat docent in zoology in the University of Bonn. — Dr. William S. Carter, professor of physiology in the University of Texas. — Dr. Anton Collin, custodian of the zoological collections in the Natural History Museum in Berlin. — Dr. W. Detmer, full professor of botany in the University of Jena. — Karl Diener, extraordinary professor of geology in the University of Vienna. — Dr. Erwin von Esmarch, professor of hygiene and bacteriology in the University of Königsberg. — Dr. Max von Frey, of Leipzig, professor of physiology in the University of Zürich. — Dr. John Y. Graham, of Princeton, professor of biology in the University of Alabama. — Dr. H. F. Harris, professor of bacteriology in Jefferson Medical College. — Dr. B. Hatschek, of Prague, professor of zoology in the University of Vienna. — Dr. Robert Hegler, privat docent in botany in the University of Rostock. — Joaquin Gonzalez Hidalgo, professor of mineralogy in the University of Madrid. — Mr. H. Higgins, demonstrator of anatomy in the University of Cambridge. — Dr. Kaiser, privat docent in mineralogy in the University of Bonn. — J. Graham Kerr, demonstrator in animal morphology in the University of Cambridge, *vice* E. W. McBride. — Dr. Georg Kraus, professor of botany in the University of Halle. — Dr. R. von Lendenfeld, of Czernowitz, professor of zoology in the German University of Prague. — Dr. Felix Ritter von Luschan, assistant in the Natural History

Museum in Berlin. — Dr. S. C. Mahalanobis, demonstrator in physiology in University College of South Wales. — Dr. Heinrich Matiegka, privat docent in anthropology in the Bohemian University in Prague. — Dr. Hermann Munk, full professor of physiology in the University of Berlin. — Prof. Wladimir Iwanowitsch Palladin, director of the Botanical Gardens at Warsaw. — Louis V. Pirsson, of New Haven, professor of physical geology in Harvard University. — Dr. W. A. Rothert, of Kazan, professor extraordinarius of botany in the University of Charkoff. — Dr. Schöndorf, privat docent in physiology in the University of Bonn. — Dr. A. W. Shern, demonstrator in anatomy in University College of South Wales. — Dr. Spiro, privat docent in physiological chemistry in the University of Strasburg. — A. F. Walden, lecturer on natural science in New College, Oxford. — Prof. A. Fischer von Waldheim goes to St. Petersburg as director of the Botanical Gardens. — Dr. P. Zwaardemaker, professor of physiology in the University of Utrecht.

Recent deaths: William Archer, of Dublin, well known for his researches on Protozoa and the lower plants. — Dr. Leopold Auerbach, professor extraordinary of physiology in the University of Breslau. — Prof. Oskar Boer, bacteriologist, in Berlin, July 11, aged 54. — Samuel Brassai, naturalist, of Klausenburg, June 24, aged 100. — Dr. M. Euchler, editor of the *Entomologischer Zeitschrift*, in Guben, Prussia, in August. — Emil Fiek, author of the *Flora of Schleswick*, in Kunersdorf, June 21. — Nikolaus Golowkinsky, formerly professor of geology and mineralogy in the Universities of Kasan and Odessa, June 9, in the Crimea. — Georg Lieder, geologist, in Bogota, July 1, aged 35. — Rev. Andrew Matthews, English student of the microcoleoptera. — Sir Peter Le Page Renouf, archæologist and for several years a keeper in the British Museum, in October, aged 75. — Charles Stewart Roy, professor of pathology in the University of Cambridge, well known as a physiologist, Oct. 4, 1897, aged 43. — Dr. Emil Schmidt, teacher of zoology in the Berlin Gymnasia. — W. Wache, director of the Zoological Gardens in Lübeck, by suicide, July 19. — Dr. Hermann Welcker, formerly professor of anatomy in the University of Halle. — Charles Bygrave Wharton, ornithologist, in Totten, England.